04-06/08/22

Logic gates :- Prepared By - Lipsa panigrahi, Lect. Electrical

AND, OR, $\underbrace{\boxed{\text{NAND, NOR}}}_{}$, EX-OR, EX-NOR,

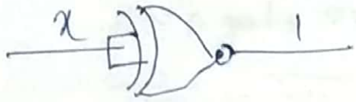
↳ universal gates.

① Equivalence / coincidence gate => $\boxed{\text{EX-NOR gate}}$

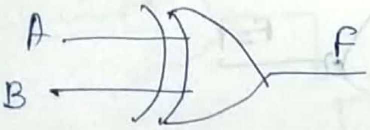
$F = A \odot B$

$\boxed{F = \bar{A}\cdot\bar{B} + A\cdot B}$

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1



② "Stair case connection" => $\boxed{\text{EX-OR}}$ logic.



$F = A \oplus B$

$\boxed{F = \bar{A}B + A\bar{B}}$

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

→ Arithmatic name for EX-OR gate is the 'modulo-2 addition'

↳ includes only (0, 1)

$0+0=0$

$0+1=1$

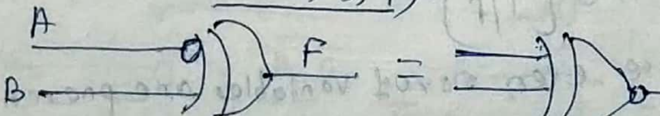
$1+0=1$

$1+1=0$

modulo-5 includes (0, 1, 2, 3, 4)

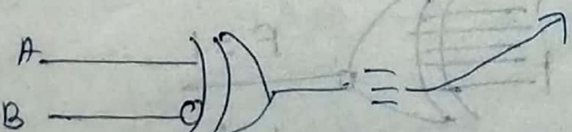
③

(a)

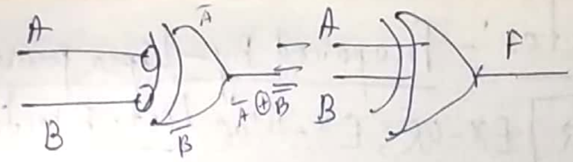


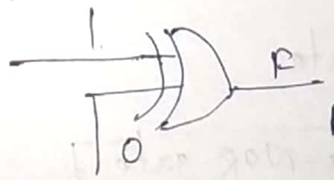
is $\bar{A} \oplus B = A \odot B$

(b)



is $A \oplus \bar{B} = A \odot B$

(c)  $\Rightarrow \overline{A} \oplus \overline{B} = A \oplus B$

(5) 

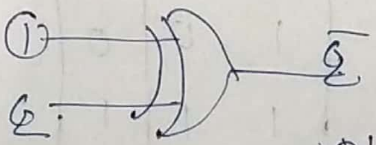
$F = \overline{A}$

Control "x"

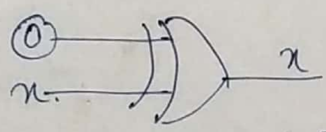
If $x = 1 \Rightarrow F = \overline{A}$ (inverter)

$x = 0 \Rightarrow F = A$ (Buffer)

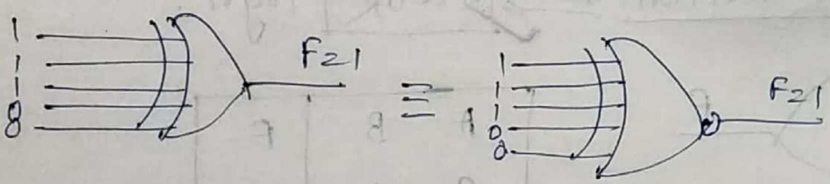
ex:-

(a) 

→ It acts as an inverter.

(b) 

→ It acts as a buffer.

(6). 

EX-OR gate ⇒ odd function

EX-NOR gate ⇒ even function

→ It's value is 1, if it contains odd no. of 1's.

→ It's value is 1, if it contains even no. of 0's.

N.B: (a) $\boxed{\overline{EX\text{-}NOR} = EX\text{-}OR}$ if no. of i/p variables are odd.

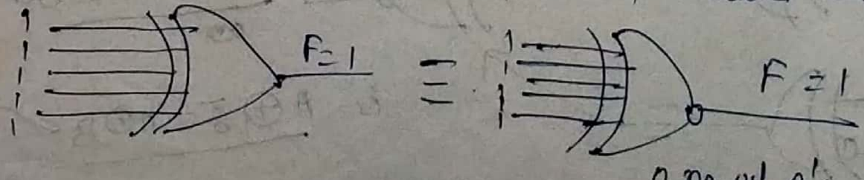
(b) $\boxed{EX\text{-}NOR = \overline{EX\text{-}OR}}$ if " " " " even.

→ For 3 variable EX-NOR = EX-OR

ex:- (i) $\overline{A \oplus B \oplus C} = A \odot B \odot C$ [T/F]

(ii) $\overline{A \oplus B} = A \odot B$ [T/F]

→ since even no. of variables are present.

(6) 

0 no. of 0's.

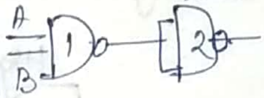
even no. of 0's so F = 1

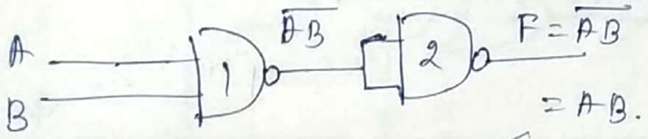
Scanned with CamScanner

(7)

	NAND	NOR
	Min. no. of gates	
EX-OR	4	5
EX-NOR	5	4
AND	2	3

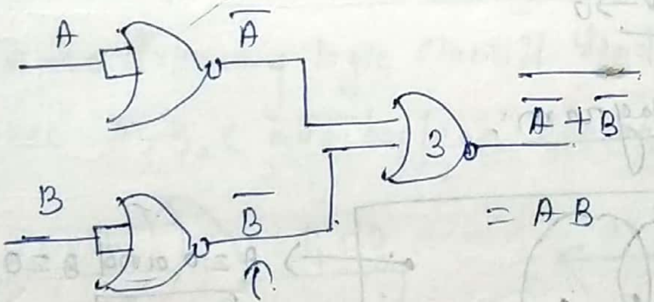
$F = A \cdot B$ $\quad F = \overline{\overline{A \cdot B}}$, 2





AND gate representation by using NAND gates.

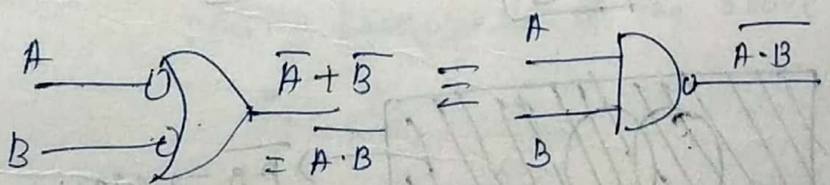
$F = \overline{\overline{AB}} = \overline{\overline{A} + \overline{B}}$



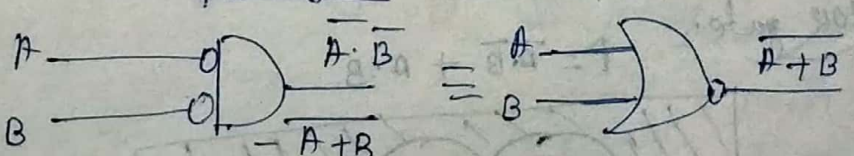
AND gate representation by using NOR gates.

(8) Bubbled gates (Negative gates):

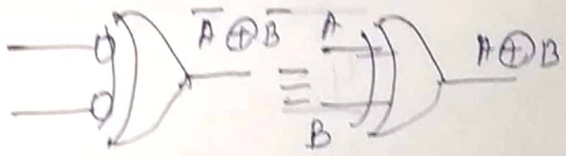
(i) Bubbled OR gate => $\boxed{\text{NAND}}$ gate.



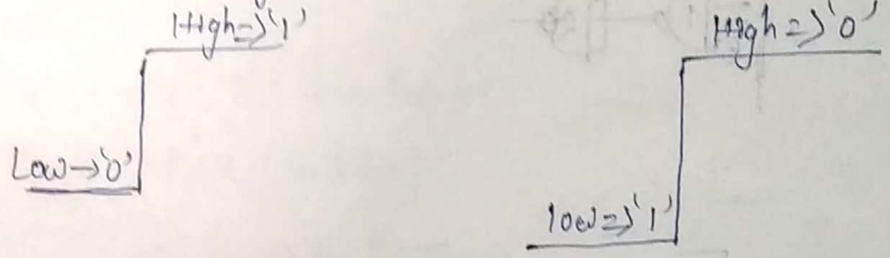
(ii) Bubbled AND gate => $\boxed{\text{NOR}}$ gate.



(iii) Bubbled EX-OR gate $\Rightarrow$ $\boxed{\text{EX-OR}}$ gate



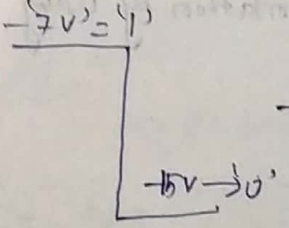
(9) Positive logic / Negative logic



ex:

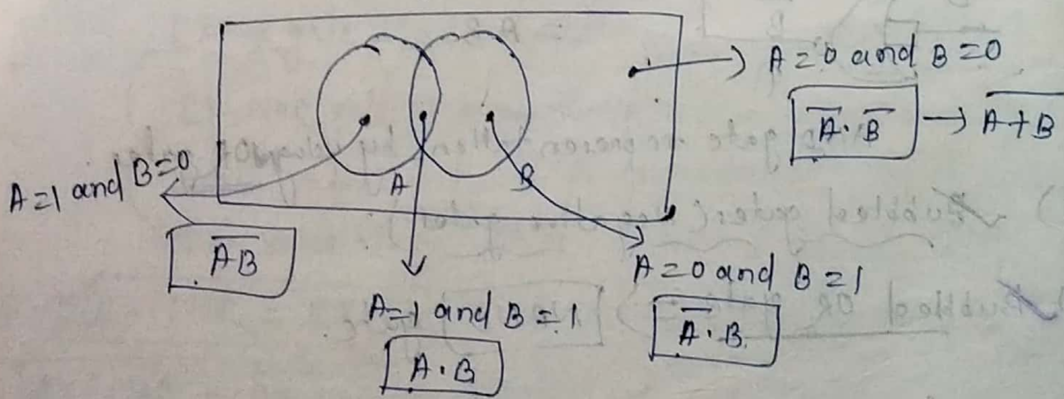
'1' ⟶ −7 V

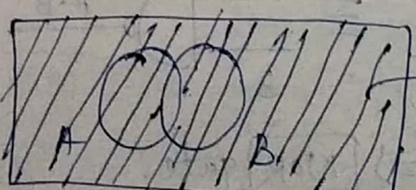
'0' ⟶ −15 V.



⟶ positive logic

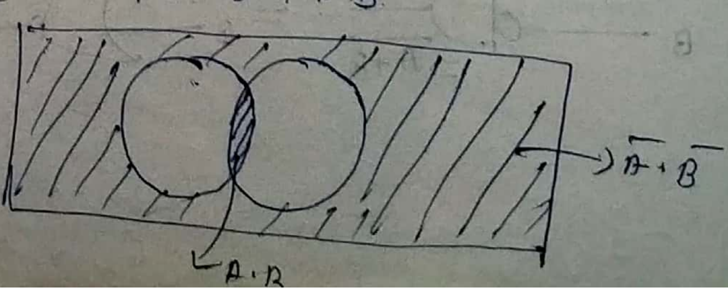
(10) Venn diagram:-





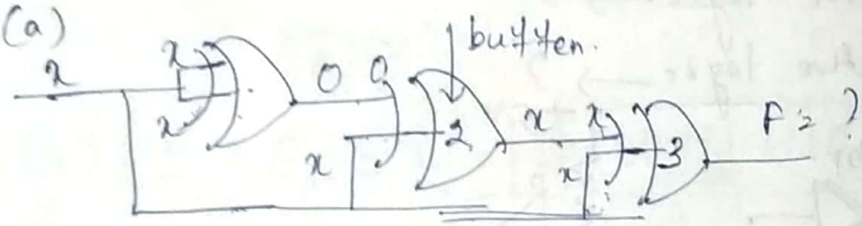
⟶ $\overline{AB}$ ⟶ NAND gate.

⟶ EX-NOR gate:- $F = \bar{A} \cdot \bar{B} + A \cdot B$



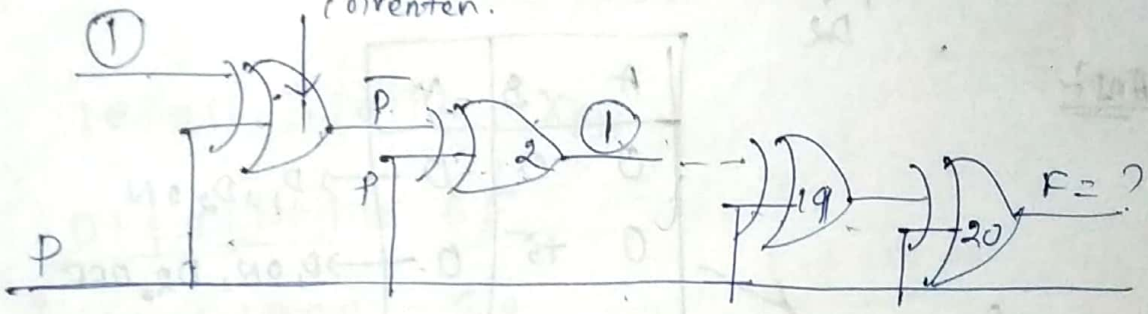
Q// Determine the o/p of the following logic circuit.

(a)



so $\boxed{F = 0}$

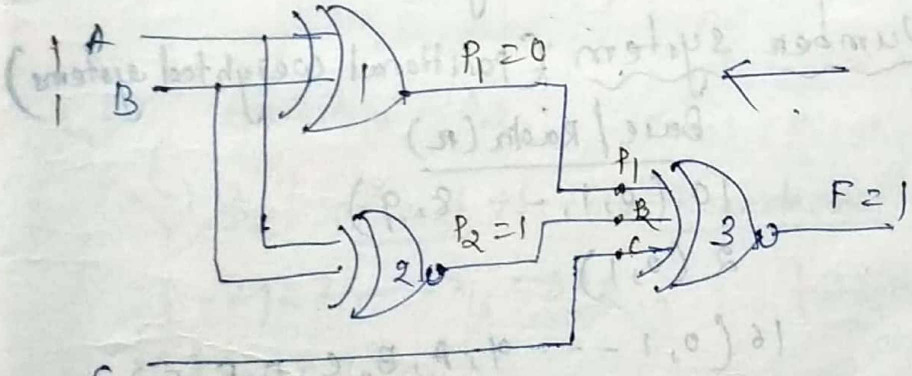
Q//



$\boxed{F = 1}$

After 2 gates it's value repeats as 1, hence after 20 gates its value is 1.

Q// In the following logic circuit find the value of C = ?
where A, B, C are boolean variables.



Moving backwards in the above circuit.

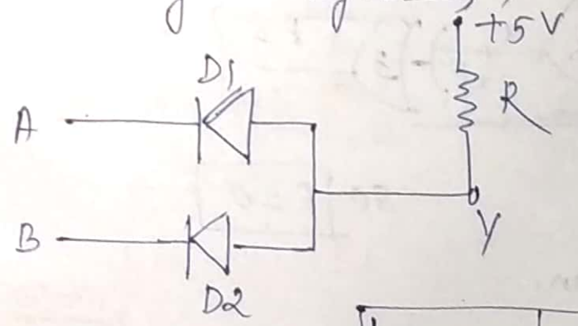
P_1	P_2	C
0	1	0
or		
1	0	0

o/p = 1 only if i/p has even no. of 0's.

Q// Determine the logic gate represented by the following circuit.

(a) positive logic → ?

(b) Negative logic → ?



Ans :-

A	B	Y	
0	0	0	→ D_1, D_2 ON
0	+5	0	→ D_1 ON, D_2 OFF
+5	0	0	→ D1 OFF, D2 → ON
+5	+5	+5	→ D1, D2 → OFF

'AND' gate (in case of +ve logic)

+5V → '1'

0V → '0'

and 'OR' gate in case of -ve logic

Number system (positional weighted systems)

	Base / Radix (r)
① Decimal	10 (0, 1, --- 8, 9)
② Binary	2 (0, 1)
③ Hexadecimal	16 (0, 1 --- 9, A, B, C, D, E, F,)
④ Octal	8 (0, 1 --- 6, 7)

eg:- Digit '6' → Base ≥ 7 ✓

Digit '8' → Base ≥ 9 ✓

Digit "D" → Base ≥ 14_{10} ✓

* Each (Hex) digit => 4 bits.

(8 4 2 1)

ex:- $(6)_{10}$ → 0 1 1 0

10_{10} → A → 10 10 .

* Each octal digit → 3 bits.
(4 2 1)

$5_8 \rightarrow 101.$

① (a) $B7E_{16} = x_2 = \boxed{101101111110_2}$

(b) $B7E_{16} \rightarrow 1011\ 0111\ 1110_2 \rightarrow x_8$

$\boxed{5576_8}$

Q// $1101111.10111_2 = x_{16}$.

$0110\ 1111 = 6F$

$1011\ 1000 = B8$

$6F.B8$

Q// How many bits required to represent 7927_{10} in binary?

Ans:- $2^n > 7927_{10} \Rightarrow \boxed{n = 13 \text{ bits}}$

$2^{10} = 1024$
$2^{11} = 2048$
$2^{12} = 4096.$
$2^{13} = 8192$

(b) $7927_{10} = x_2$

→ first convert it in to Hexadecimal and then to binary.

$7927_{10} \rightarrow x_{16} \rightarrow x_2$

$$
\begin{array}{r|l}
16 & 7927 \\
16 & 495 - 7 \\
16 & 30 - 15(F) \\
16 & 1 - 14(E) \\
 & 0 - 1.
\end{array}
$$

$= (1EF7)_{16} \rightarrow \cancel{000}\boxed{1111011110111_2}$

Q// Determine the base of the following

$\sqrt{41} = 5$ base = ?

Ans:- Base ≥ 6

Convert unknown system to decimal system.

$$\boxed{\begin{aligned} &36_8 \xrightarrow{3\times 8^1+6\times 8^0} \\ &101_2 \xrightarrow{1\times 2^2+0+1\times 2^0} X_{10}. \\ &132_x \xrightarrow{1\times x^2+3x+2} \end{aligned}}$$

Let Base = x.

$$= \left(\sqrt{4\times x^1+1\times x^0}\right)_{10} = (5\times x^0)_{10}$$

$$= \sqrt{4x+1} = 5$$

$$\Rightarrow 4x+1 = 25$$

or $\boxed{x=6}$

Q// Min decimal value of $11C_x = ?$ [1 2 3 4]

Sol^n since the maximum digit = C = 12_{10}.

so $\boxed{\text{base} \geq 13}$

Convert $11C_x$ to decimal.

$$1\times x^2+1\times x+C\times x^0 = [x^2+x+12]_{10}$$

to get the min value

substitute $x = 13$

so min decimal value of $11C_x = (13)^2+13+12$

$= 169+25 = 194_{10}$.

Imp

Q// In a positional weighted no. system the roots of a quadratic eq^n

$$x^2-11x+22 = 0 \Rightarrow \boxed{x=3} \text{ and } \boxed{x=6}$$

find the base of the no. system.

Sol^n:- As the max. digit = 6

hence base ≥ 7

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

$$11_b \xrightarrow{1\times b^1+1\times b^0} (b+1)_{10}$$

$$22_b \xrightarrow{2\times b^1+2\times b^0} (2b+2)_{10}$$

$$3_b \longrightarrow 3\times b^0 = 3_{10}$$

convert all co-efficients into decimal.

let base = b.

$$x^2 - (b+1)x + (2b+2) = (x-3)(x-6) = (x^2 - 9x + 18)_{10}$$

$\Rightarrow 2b+2 = 18$

or $\boxed{b = 8}$

Q//.

$$\begin{array}{r} 1.2_4 \\ +\ 2.3_4 \\ \hline 10.1_4 \end{array}$$

$2 + 3 = 5_{10} \rightarrow x_4 = ?$

$4_{10} \rightarrow x_4 = (10_4)$

$$\begin{array}{r|l} 4 & 5 \\ 4 & 1 \ -\ 1 \\ & 0 \ -\ 1 \end{array}$$

$= (11_4)$

$$\begin{array}{r|l} 4 & 4 \\ 4 & 1 \ -\ 0 \\ & 0 \ -\ 1 \end{array}$$

$(10)_{10}$

0 - - - 9,

10 - - - 19

20 - - - 29

2nd method :-

① 1.2_4
$+\ 2.3_4$
10.1_4
Carry

$(10.1)_4$.

Base - 4

0
1
2 $(2)_4$
3 $+(3)_4$
10
11 $(11)_4$.
12
13
20
21
22
23

Complementary Number :-

$= A - B$

$= A + (-B)$

$= \boxed{A + (\text{complement of } +B)}$

Base = r'

(r−1)'s complement

$\boxed{r\text{'s complement} = (r-1)\text{'s complement} + 1}$

Decimal system (r = 10) :-

→ 9's complement of $(617)_{10}$ =

$$\begin{array}{r} 9\ 9\ 9 \\ -\ 6\ 1\ 7 \\ \hline =(3\ 8\ 2)_{10} \end{array}$$

→ 10's complement of $(617)_{10} = 382 + 1 = (383)_{10}$

Binary system (r = 2) :-

1's complement of 101_2 =

$$\begin{array}{r} 1\ 1\ 1 \\ -\ 1\ 0\ 1 \\ \hline (0\ 1\ 0)_2 \end{array}$$

2's complement of $101_2 = 010 + 1 = (011)_2$

E// 10's complement of $(316)_{11}$ = ?

Ans:- r = 11 → 0, 1 - - . 9, A.

$$\begin{array}{r} A\ \ A\ \ A \\ -\ 3\ \ 1\ \ 6 \\ \hline (7\ \ 9\ \ 4)_{11} \end{array}$$

E// 9's complement of $(316)_{11}$ = ?

It does not exist

E// P = $\underbrace{101110}_{\text{complement}}\underbrace{1000}_{\text{copy}}$

2's complement of P =

0100011000

starting from the right side copy all the bits till the first 1 appeared then complement the other bits.

E// x = 10000

2's complement of x = 10000.

$5_{10} - 2_{10} = 0101_2 - 0010_2$

$= 0101 + (-0010)$

$= 0101 + (\text{complement of } 0010)$

$0101 + (\text{1's complement of } 0010)$

$= 0101 + 1101$

$\Rightarrow$

$$\begin{array}{r} 0101 \\ +\ 1101 \\ \hline \text{EOC } 1\ \ 0010 \\ +\ \ \ \ 1 \\ \hline 0011 = 3_{10} \end{array}$$

$0101 + (\text{2's complement of } 0010)$

$= 0101 + 1110.$

$\Rightarrow$

$$\begin{array}{r} 0101 \\ +\ 1110 \\ \hline \text{EOC } 1\ \ 0011 = 3_{10}. \end{array}$$

EOC 1 should not be considered.

→

1's comp	2's comp
$+0 = 0000$	$+0 = 0000$
-0 = 1's comp of $+0$	-0 = 2's comp of $+0$.
= 1's comp " 0000	= 2's " 0000
⇒ 1111	= 0000

Imp: The drawback of 1's complement form is +0 and −0 are represented separately whereas in 2's complement form there is no difference in the representation of +0 and −0. Hence all digital system adapt 2's complement form only.

Q// How many bits are required to represent 32 digit decimal no.

$\boxed{2^n \geq 32}$

→ Represent +8 and −8 in 4 bit 2's complement form.