COMPUTER SCIENCE & IT

DIGITAL LOGIC

Lecture No. 08

BOOLEAN THEOREMS AND GATES

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Universal gates

Universal gate Cont.

Q. $y = \bar{A}B + B\bar{C}$

$$\bar{y} = \overline{\bar{A}\cdot B} \cdot \overline{B\bar{C}} = P \cdot Q$$

$P \rightarrow$ 2NAND

$Q \rightarrow$ 2NAND

$$y = \overline{P \cdot Q}$$

$\rightarrow$ 1NAND

5NAND

$$\Rightarrow \quad y = B(\bar{A} + \bar{C}) = B \cdot \overline{AC} = B \cdot R$$

$R \rightarrow$ 1NAND

$B \cdot R \longrightarrow$ 2NAND

3NAND

\# $y = A\cdot(B+C)$

$$\left.\begin{array}{l} (B+C) \longrightarrow 3\,\text{NAND} \longrightarrow P \\ A\cdot P \longrightarrow 2\,\text{NAND} \end{array}\right\}$$

$y = A\cdot B + A\cdot C$

$\bar{y} = \overline{AB + AC} = \overline{AB}\cdot\overline{AC} = Q\cdot R$

$Q \rightarrow$ 1 NAND

$R \rightarrow$ 1 NAND

$y = \overline{Q\cdot R} \rightarrow$ 1 NAND

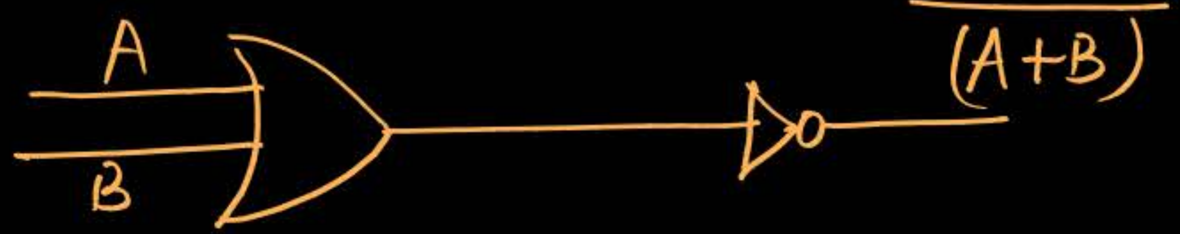
$f(A,B,C) = \Sigma(1,2,4,7)$

$= A\oplus B\oplus C$

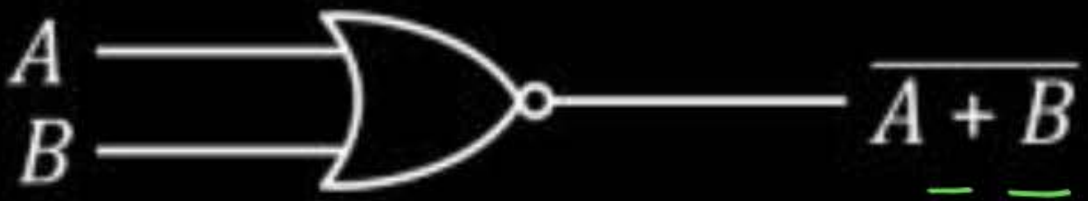
$$\left.\begin{array}{l} A\oplus B \longrightarrow 4\,\text{NAND} \longrightarrow P \\ P\oplus C \longrightarrow 4\,\text{NAND} \longrightarrow \end{array}\right\} 8\,\text{NAND}$$

[NOR GATE]

$\boxed{\text{OR+NOT}}$,



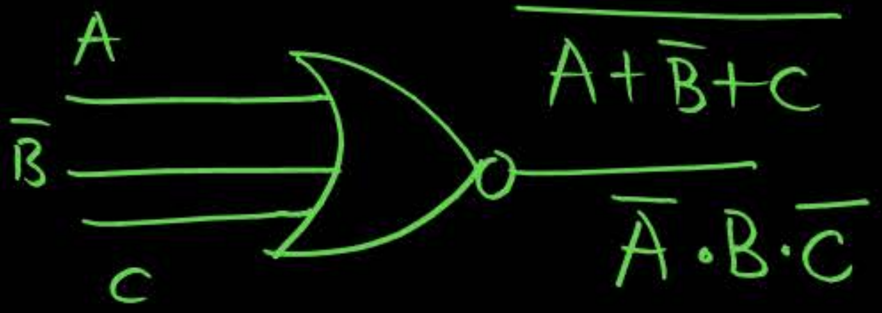
Representation :



$= \bar{A} \cdot \bar{B}$

|||

$= \overline{A+B}$



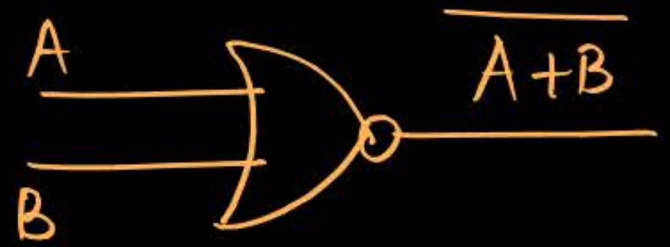
	A	B	$y = \overline{A+B}$
0	0	0	1
1	0	1	0
2	1	0	0
3	1	1	0

$y(A, B) = \Sigma(0)$

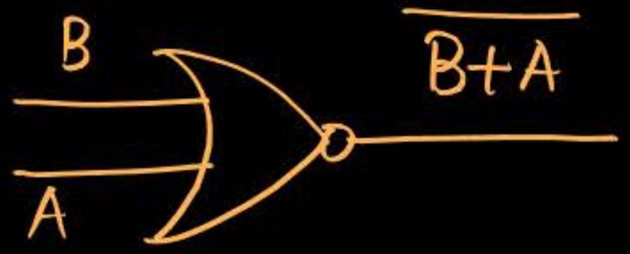
$= \pi(1,2,3)$

$= \bar{A} \cdot \bar{B} = \overline{A+B}$

- Commutative Law :



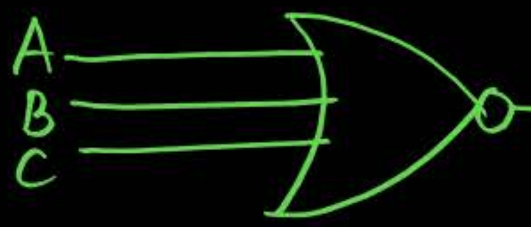
$\equiv$

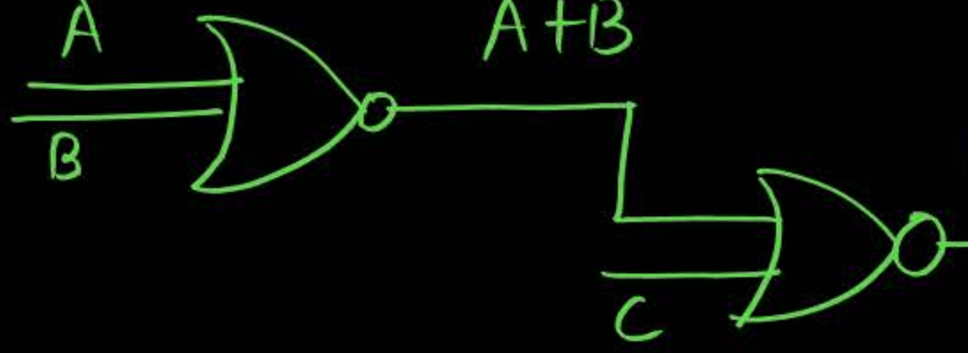


$= \overline{A+B}$

$\boxed{\text{It holds commutative law} \rightarrow \text{position of variables is irrelevant}}$

- Associative Law :





$$\overline{A+B+C} = \bar{A}\cdot\bar{B}\cdot\bar{C} \neq \overline{(\overline{A+B})+C} = (A+B)\cdot\bar{C}$$

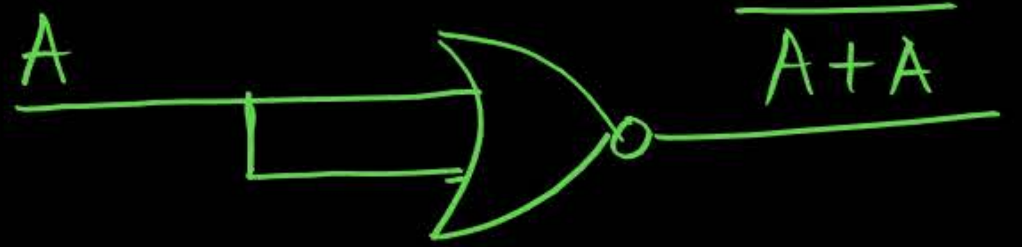
It does not hold associative law.

- IMP Points :

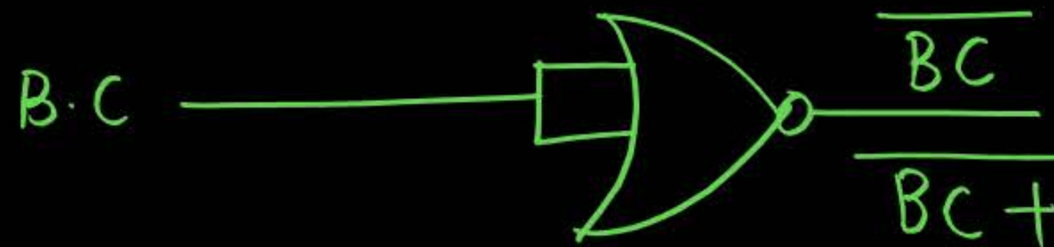
- If any one of i/p line is at logic '1' then irrespective of other i/p lines, o/p will be at logic '0'.
- O/p will be '1' only in one case if all the i/p lines will be at logic '0'.

NOR GATE as Universal Circuit

- NOT GATE



$$\overline{A+A} = \overline{A}$$

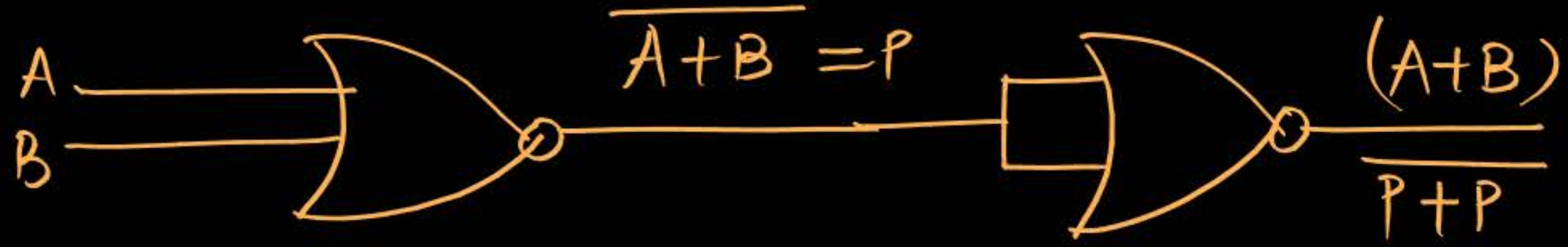


$$\overline{BC}$$

$$\overline{BC + B\cdot C}$$

$$\overline{BC}$$

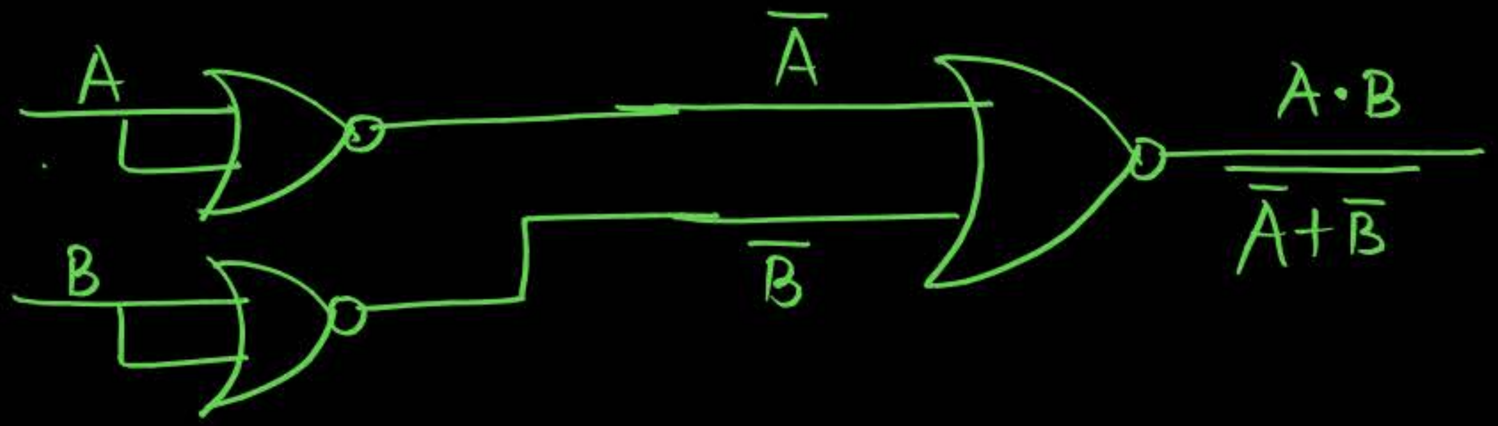
- OR GATE



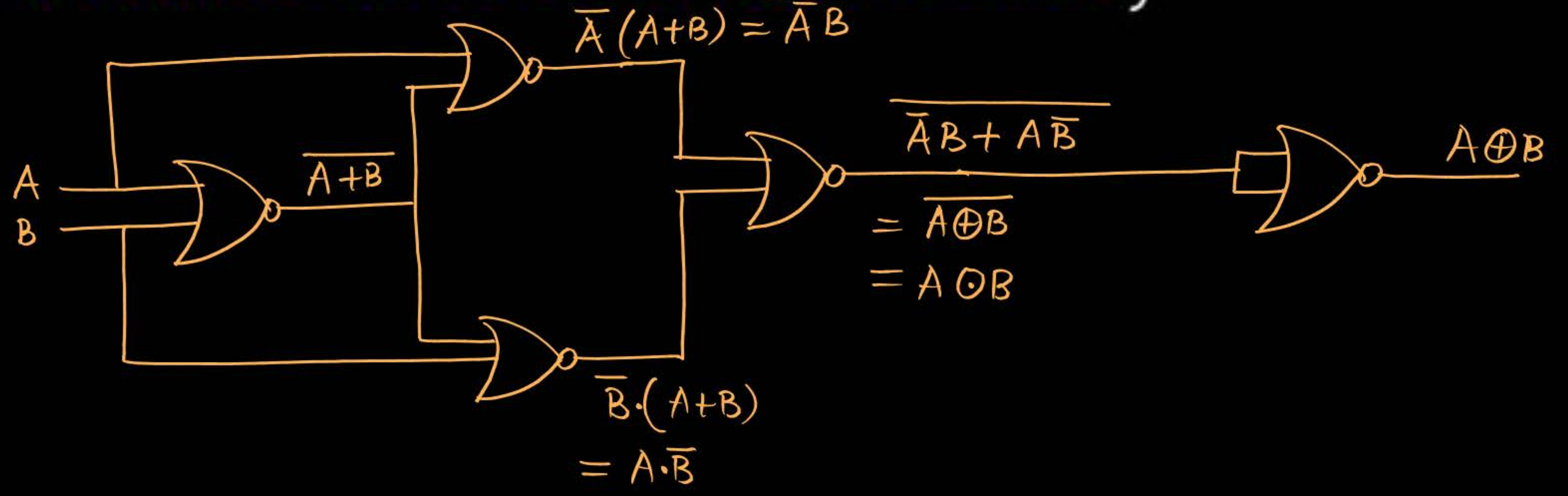
$$\overline{P+P}$$

$$= \overline{P} = \overline{A+B} = (A+B)$$

- AND GATE



XOR and XNOR GATE using NOR GATE



GATES	No. of NAND	No. of NOR
	2 i/p	2 i/p
NOT	1	1
AND	2	3
OR	3	2
XOR	4	5
XNOR	5	4

Q. $y = (A+B)\cdot(B+C)$

Minimum no. of $\overset{2\,i/p}{\wedge}$ NOR gate require to implement this o/p $\underline{\quad 3 \quad}$.

$(A+B) \longrightarrow 2\text{ NOR} \Rightarrow P$

$(B+C) \longrightarrow 2\text{ NOR} \Rightarrow Q$

$P\cdot Q \longrightarrow 3\text{ NOR} \rightarrow y$

7 NOR

$\bar{y} = \overline{(A+B)\cdot(B+C)} = \overline{(A+B)} + \overline{(B+C)}$

$= R + S$

1 NOR

1 NOR

$y = \overline{R+S}$

1 NOR

#Q. $y = (A+\bar{B})\cdot(A+\bar{C}) = A + \bar{B}\cdot\bar{C} = A + \overline{(B+C)} = A + R$

Minimum no. of 2-i/P NOR gate required to implement above function ______.

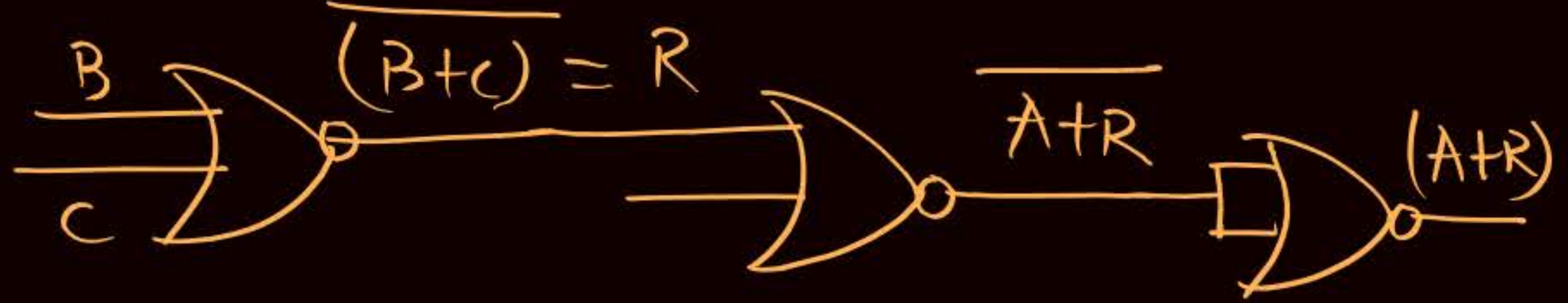
$$\bar{y} = \overline{(A+\bar{B})} + \overline{(A+\bar{C})} = \underbrace{P}_{\text{2 NOR}} + \underbrace{Q}_{\text{2NOR}}$$

$$y = \underbrace{\overline{P+Q}}_{\text{1NOR}}$$

• $y = A + \overline{(B+C)} = A + \underbrace{R}_{\text{1NOR}}$

$A+R \longrightarrow$ 2NOR

$\Big\}$ 3NOR



#Q. $y = A + (B \cdot C) \longrightarrow$

Minimum no. of 2-i/p NOR gate required to implement y $\underline{\quad 3 \quad}$.

$$y = (A+B)\cdot(A+C)$$

$$\bar{y} = \overline{A+B} + \overline{A+C} = P + Q$$

P → 1 NOR

Q → 1 NOR

$$y = \overline{P+Q} \rightarrow 1\,\text{NOR}$$

Q. $y = \bar{A}\bar{B} + \bar{B}\bar{C}$

Minimum no. of 2-i/P NOR gate required to implement y $\underline{\quad 4 \quad}$.

$$y = \underbrace{\overline{A+B}}_{\text{1NOR} \; P} + \underbrace{\overline{B+C}}_{\text{1NOR} \; Q} = P+Q$$

$P+Q \longrightarrow 2\text{NOR}$

#Q. $y = (\bar{A}+B)\cdot(A+\bar{B})$

Minimum no. of 2-i/P NOR required to implement y $\underline{\quad 4 \quad}$.

$\Rightarrow \bar{y} = \overline{(\bar{A}+B)} + \overline{(A+\bar{B})} = P+Q \rightarrow$ 2NOR

$P \rightarrow$ 2NOR

$y = \overline{P+Q} \longrightarrow$ 1NOR

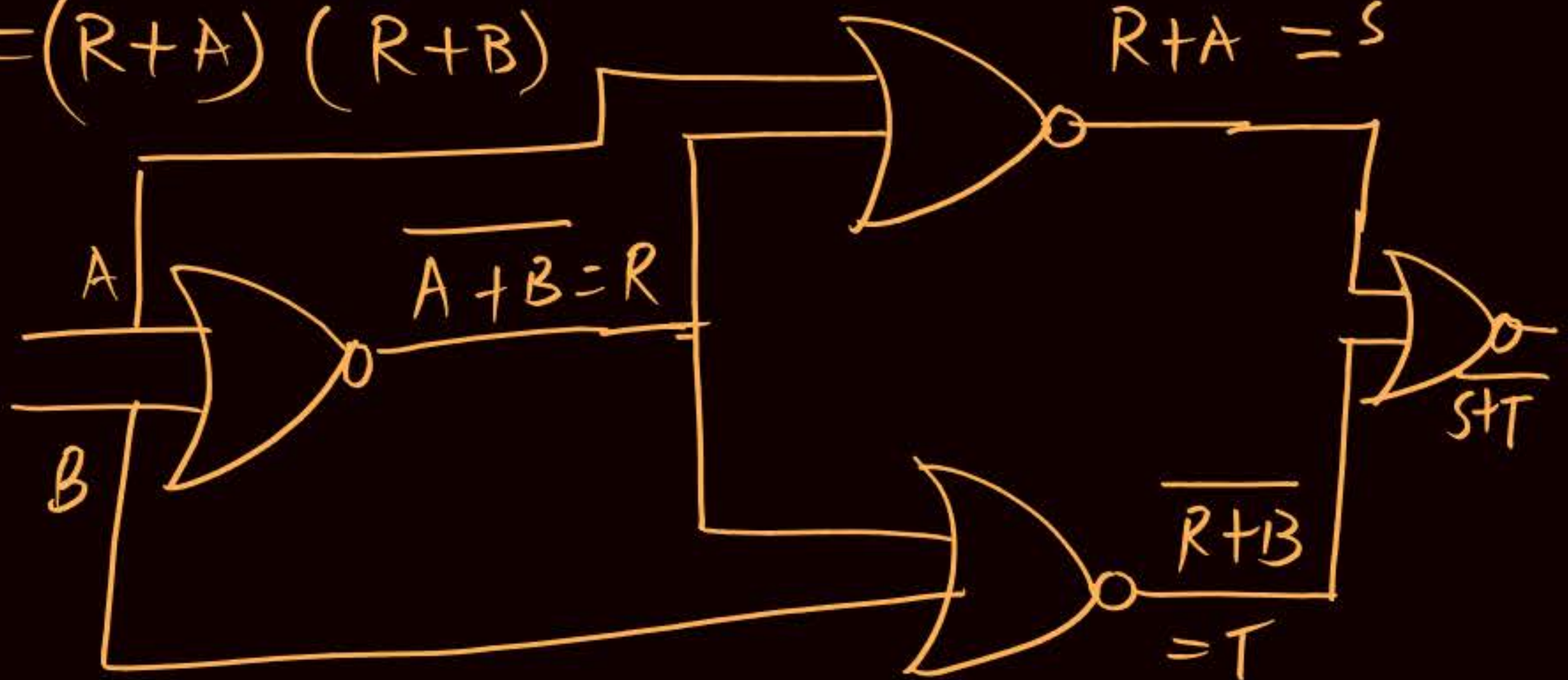
$y = \underline{\underline{\bar{A}\bar{B}}} + AB = \overline{(A+B)} + AB = R + (AB) = (R+A)(R+B)$

$R \rightarrow$ 1NOR

$\bar{y} = \overline{R+A} + \overline{(R+B)} = S + T \rightarrow$ 1NOR

$S \rightarrow$ 1NOR

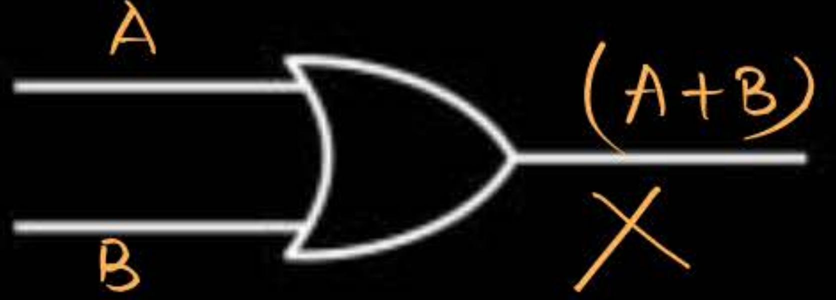
$y = \overline{S+T} \longrightarrow$ 1NOR



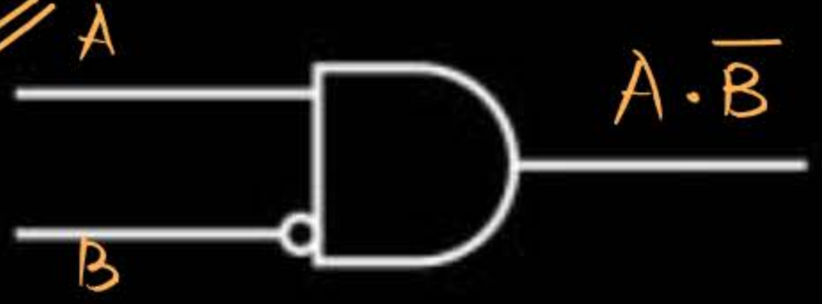
Question

Which of the following circuit can work as universal gate ?

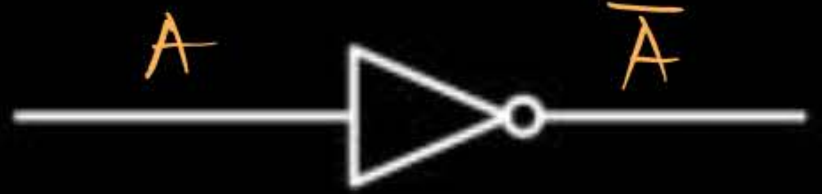
(a)



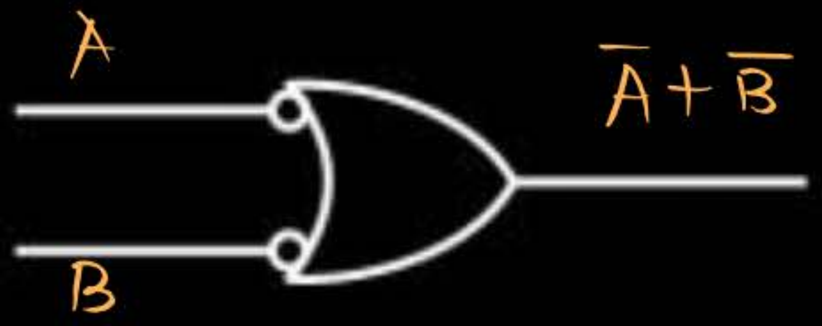
(b)

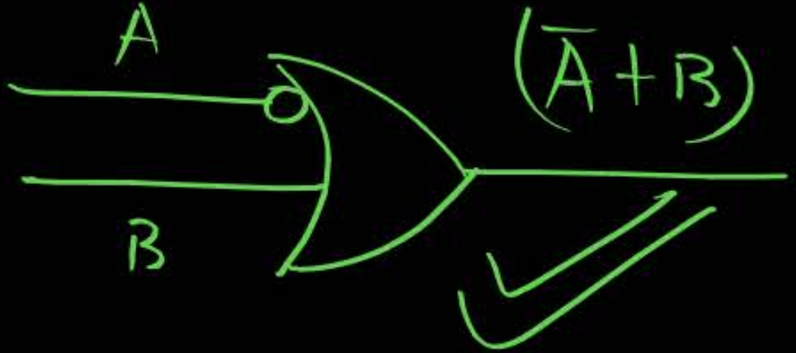


(c)



(d)

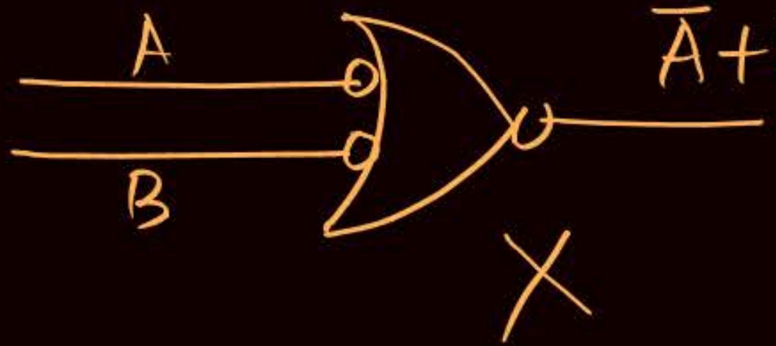




AND + NOT $\longrightarrow$ $\overline{\bar{A} \cdot \bar{B}} = (A + B)$

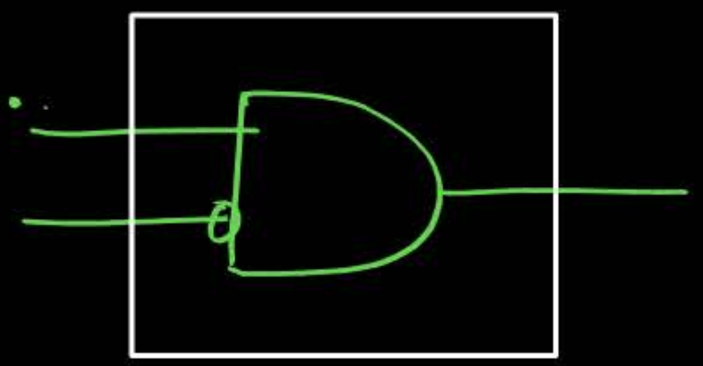
OR + NOT $\longrightarrow$ $\overline{\bar{A} + \bar{B}} = A \cdot B$

Can work as universal gate.

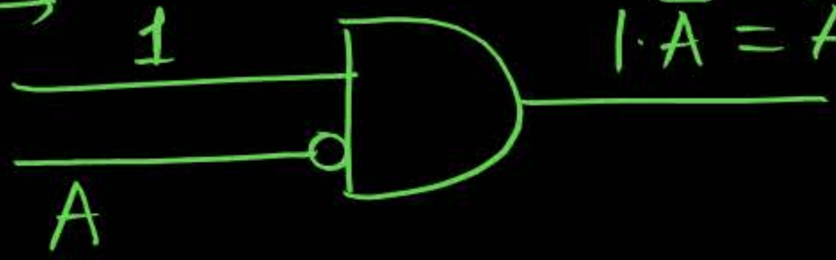


$\overline{\bar{A} + \bar{B}} = A \cdot B$

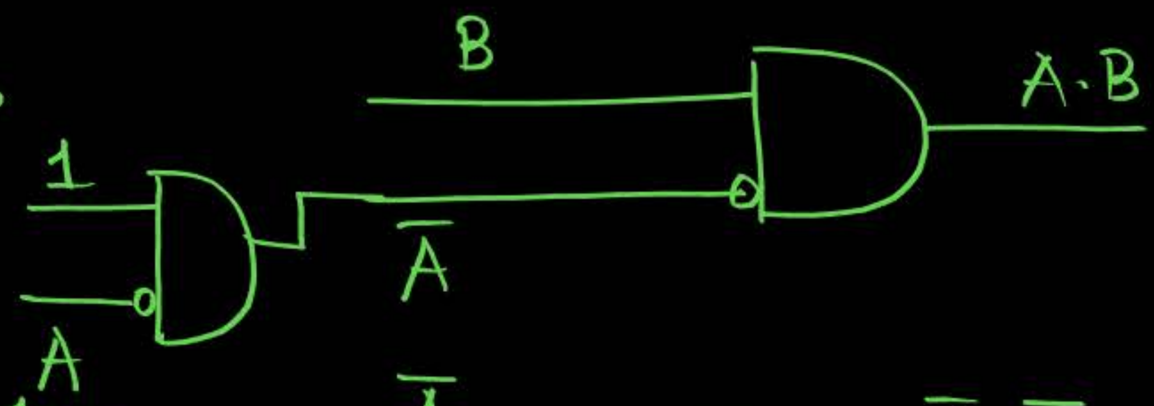
$\overline{\bar{A} \cdot \bar{B}}$



$A \rightarrow$



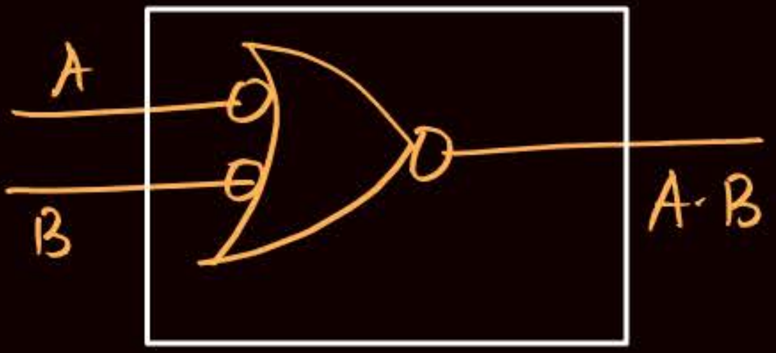
$1 \cdot \bar{A} = \bar{A}$ NOT gate



$A \cdot B$ AND

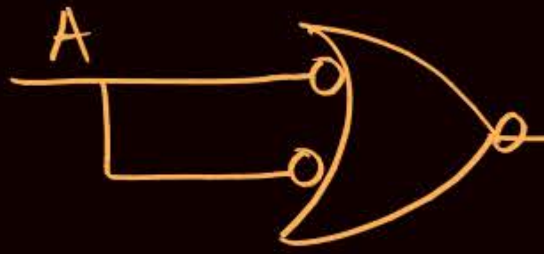
$\overline{\bar{A} \cdot \bar{B}} = (A + B)$

OR

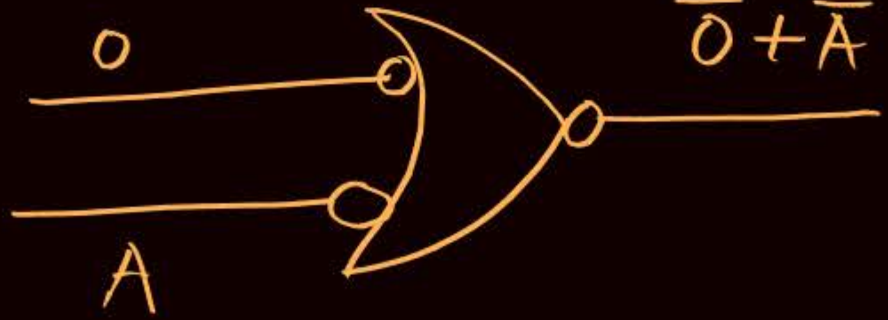


Can not work as universal gate.

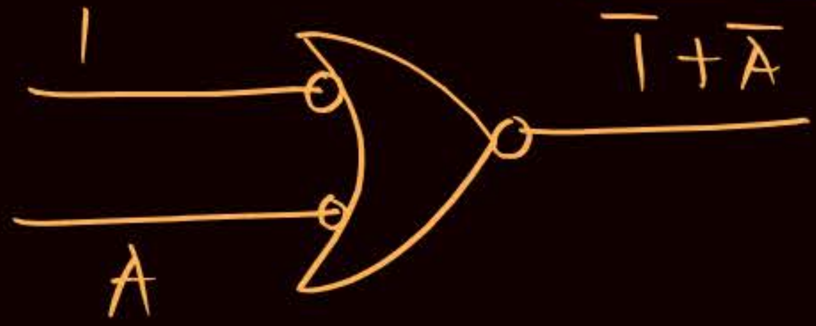
A



$\overline{\overline{A}+\overline{A}} = A$ ✗ ,

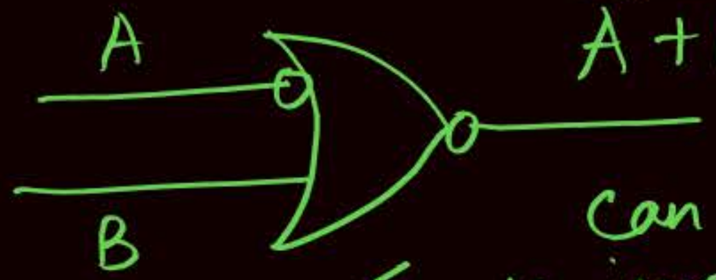


$\overline{\overline{0}+\overline{A}} = 0$ ✗



$\overline{\overline{1}+\overline{A}} = A$ ✗

NOT operation is not possible using this unit so it will not work as universal gate.



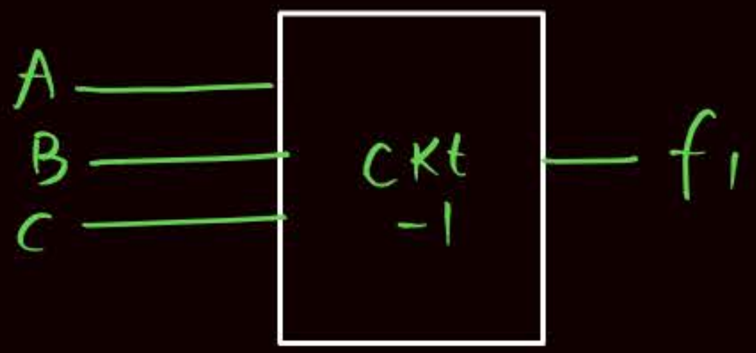
$$\overline{\bar{A} + B} = A \cdot \bar{B}$$

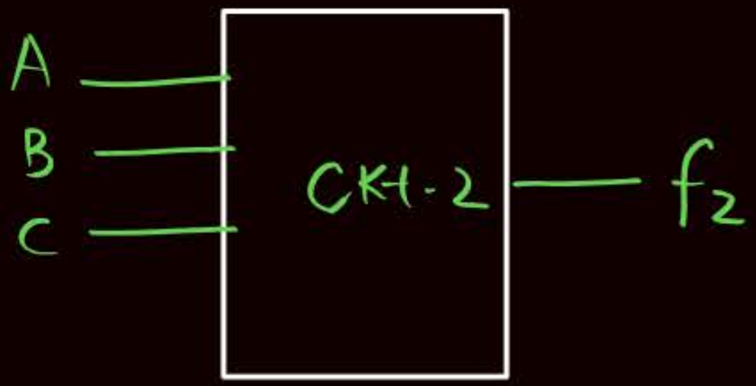
Can work as universal ckt

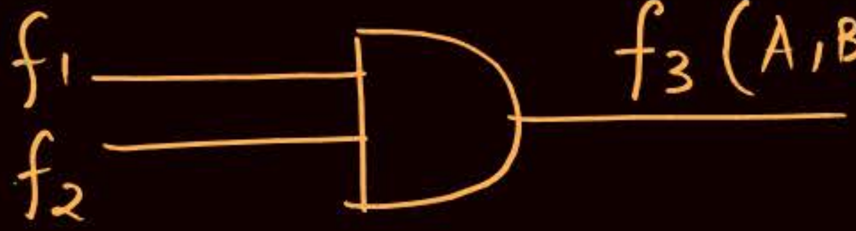
#Q.

$$f_1(A,B,C) = \sum(1,2,3,6,7)$$

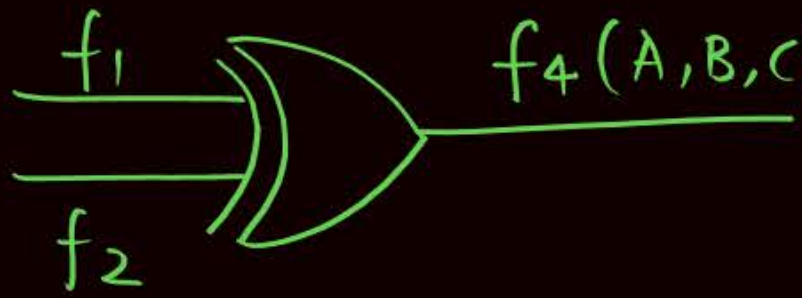
$$f_2(A,B,C) = \sum(0,2,3,5,7)$$



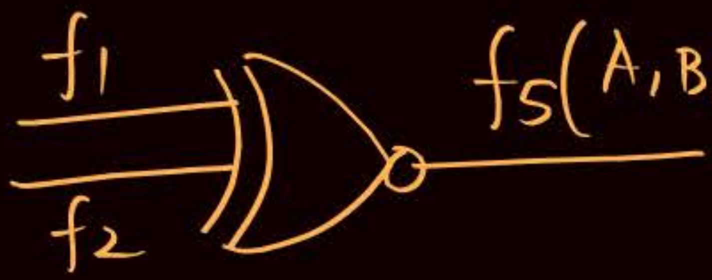


- 

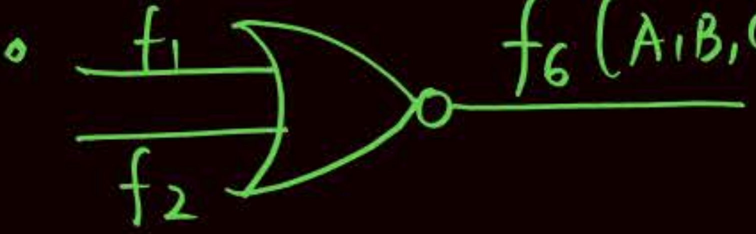
$$f_3(A,B,C) = \sum(2,3,7)$$

- 

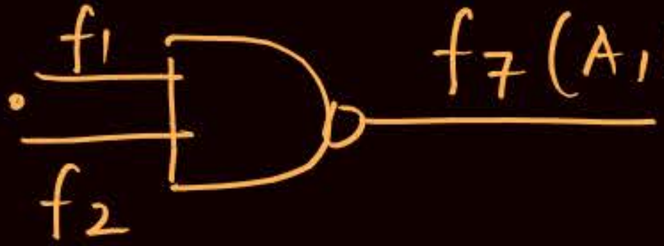
$$f_4(A,B,C) = \sum(0,1,5,6)$$

- 

$$f_5(A,B,C) = \sum(2,3,4,7)$$

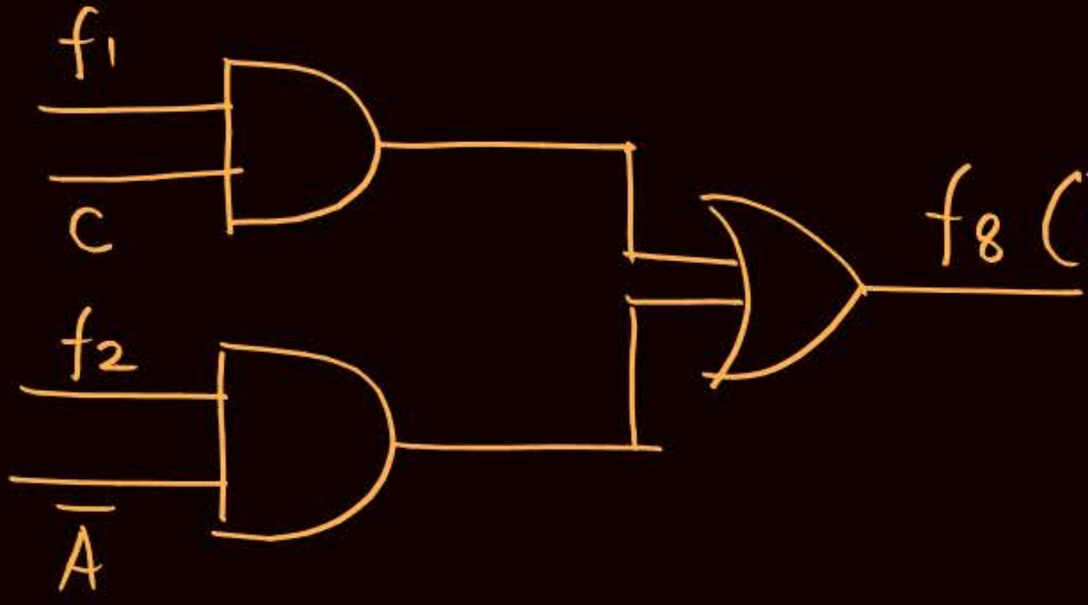


$f_6(A,B,C) = \Sigma(4)$



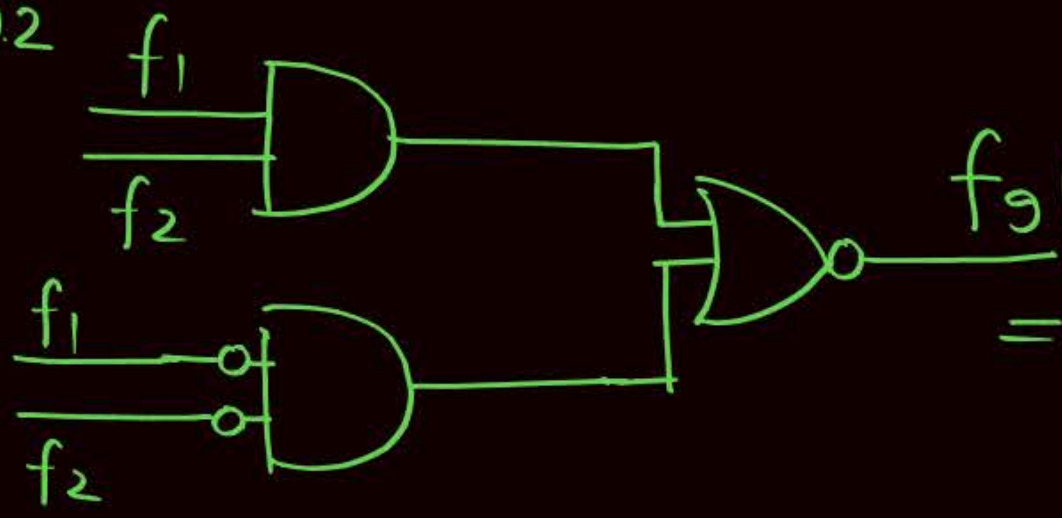
$f_7(A,B,C) = \Sigma(0,1,4,5,6)$

H.W. Q.1



$f_8(A,B,C) = \Sigma$

Q.2



$f_9(A,B,C) = \Sigma$

#Q. Minimum no. of NOR gate required to implement the functions given below:

a. $y = A\bar{B} + \bar{A}B$

✓ b. $y = (\bar{A} + B)(B + \bar{C})(\bar{A} + D)(\bar{C} + D)$

c. $y = (\bar{A} + \bar{B})(C + D)$

2 Minute Summary

→ Universal gates

Thank you

GW

Soldiers !