EX-OR & EX-NOR properties:-

1. $A \oplus A = 0$

2. $A \odot A = 1$

3. $A \oplus 0 = A$

4. $A \odot 0 = \overline{A}$

5. $A \oplus 1 = \overline{A}$

6. $A \odot 1 = A$

7. $A \oplus \overline{A} = 1$

8. $A \odot \overline{A} = 0$

9. $\overline{A} \oplus \overline{B} = A \oplus B$

10. $\overline{A} \odot \overline{B} = A \odot B$

11. if $A \oplus B = C$

    then $A \oplus C = B$

    $B \oplus C = A$

    $A \oplus B \oplus C = 0$

12. if $A \odot B = C$

    then $A \odot C = B$

    $B \odot C = A$

    $A \odot B \odot C = 1$

Let $x = \overline{A}$, $\overline{x} = A$

$y = \overline{B}$, $\overline{y} = B$

$$\overline{A} \oplus \overline{B} = x \oplus y$$

$$= x\overline{y} + \overline{x}y$$

$$= \underline{A \oplus B}$$

13. if $A \oplus B \oplus C = D$

    then $A \oplus B \oplus D = C$

    $A \oplus C \oplus D = B$

    $B \oplus C \oplus D = A$

    $A \oplus B = C \oplus D$

    $A \oplus C = B \oplus D$

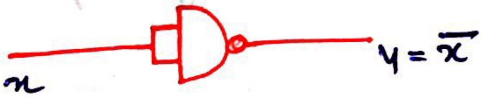
    $B \oplus C = A \oplus D$

    $A \oplus B \oplus C \oplus D = 0$

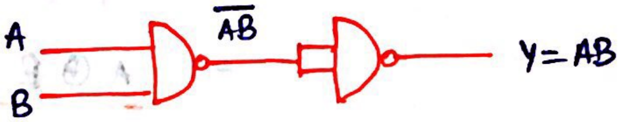
* NAND & NOR are functionally complete set universal logic gates.

Using NAND :-

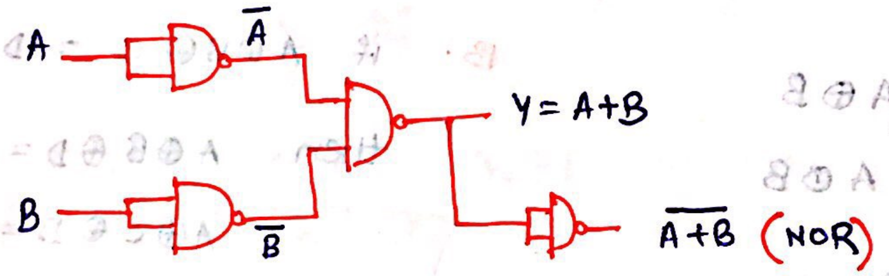
NOT



AND

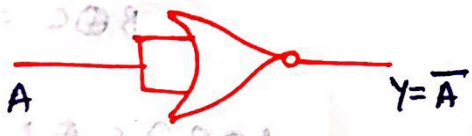


OR

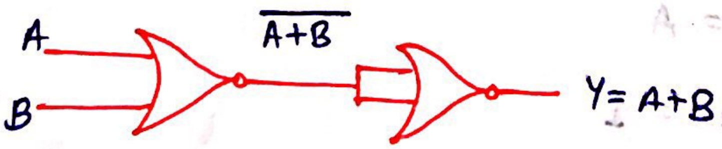


Using NOR :-

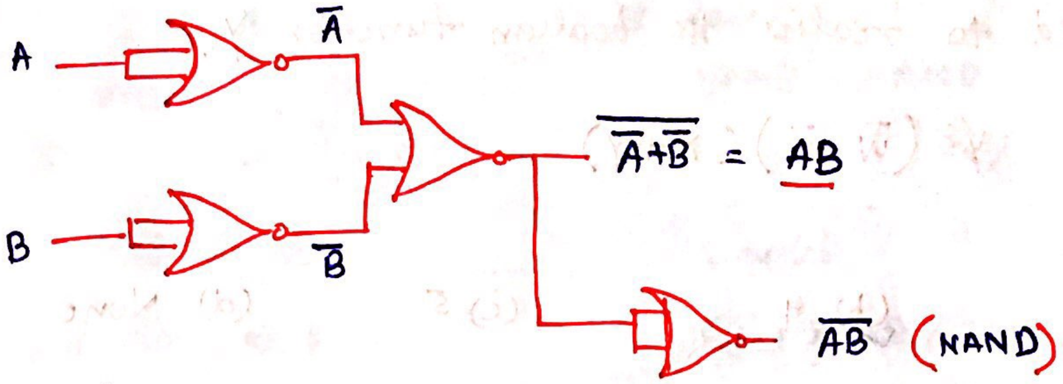
NOT



OR ~~AND~~



AND



NOTE:-

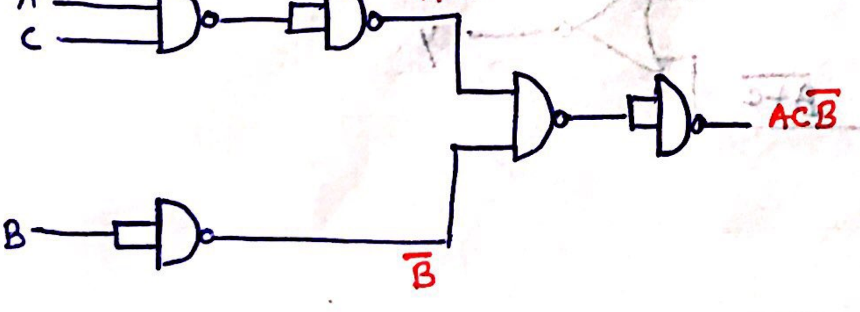
$\left.\begin{array}{l}\underbrace{\{AND,\ NOT\}}_{NAND} \\ \underbrace{\{OR,\ NOT\}}_{NOR}\end{array}\right\}$ Functionally complete

Q. Identify the minimum no. of 2 I/p NAND Gates requires to realize the boolean function.

$$f(A,B,C) = A\overline{B}C$$

(a) 3 (b) 4 (c) 5 ✓ (d) 6

$f = (AC)\,\overline{B}$



Q. Identify the minimum no. of 2 I/p NAND gates required to realize the boolean function Y.

$$Y = (\bar{W} + \bar{Z})(X+Y)$$

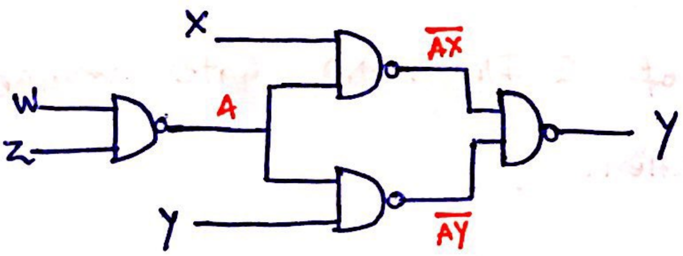
(a) 3 (b) 4 (c) 5 (d) None

$$Y = \overline{W \cdot Z}\,(X+Y)$$

$$Y = A(X+Y) \qquad \text{Let } A = \overline{W \cdot Z}$$

$$Y = AX + AY$$

$$Y = \overline{\overline{AX} \cdot \overline{AY}}$$

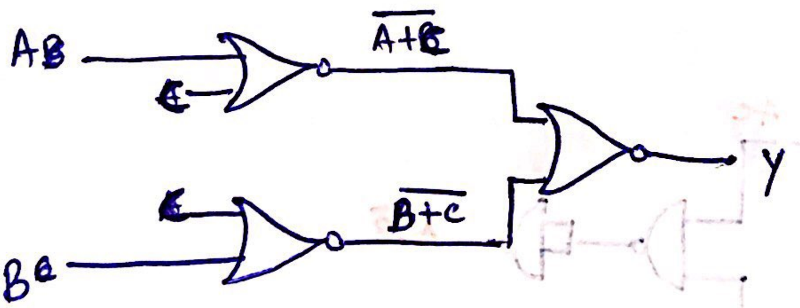


Q. Identify minimum no. of 2 I/p NOR gates required to realize the boolean function Y = C + AB.

(a) 3 (b) 4 (c) 5 (d) None.

$$Y = (C+A)(C+B)$$

$$Y = \overline{\overline{A+C} + \overline{B+C}}$$

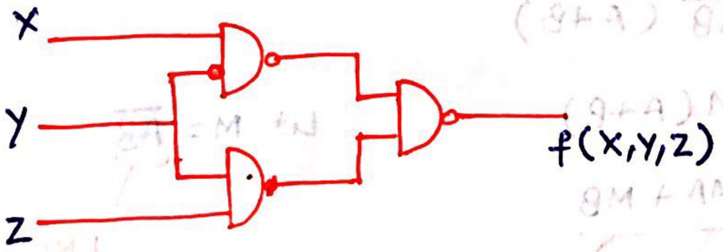


NOTE :-

2 level AND — OR $\longleftrightarrow$ 2 level NAND — NAND

2-level OR — AND $\longleftrightarrow$ 2 level NOR — NOR

Q.



What is the minimum no. of NAND & NOR gates to implement the above ckt.

(a) 1, 4 ✓ (b) 4, 1 (c) 2, 4 (d) None

$$f = \overline{\overline{XY} \cdot YZ} = XY + \overline{YZ}$$

$$= \overline{(\bar{x} + \bar{y})\, YZ}$$

$$= \overline{\bar{X}YZ + YZ}$$

$$= \overline{YZ}$$

1 NAND

4 NOR

Q. Minimum no. of two I/p NAND gates required to realize XOR gate.

(a) 3 (b) 4 (c) 5 (d) None

$$Y =$$

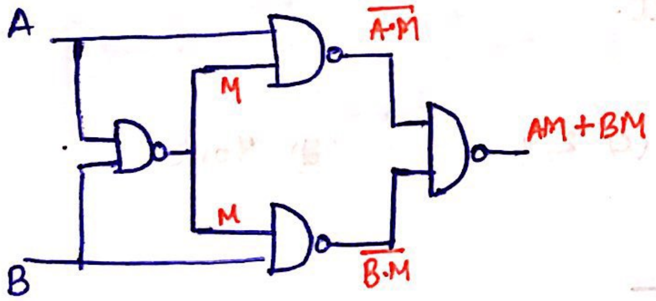
$$= A \oplus B$$

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

$$= \overline{AB}\,(A+B)$$

$$= M(A+B) \qquad \text{Let } M = \underbrace{\overline{AB}}_{1\ \text{NAND}}$$

$$= \underbrace{MA + MB}_{3\ \text{NAND}}$$



Q. Minimum no. of two I/p NAND gates required to realize XNOR gate

(a) 3 (b) 4 (c) 5 (d) None

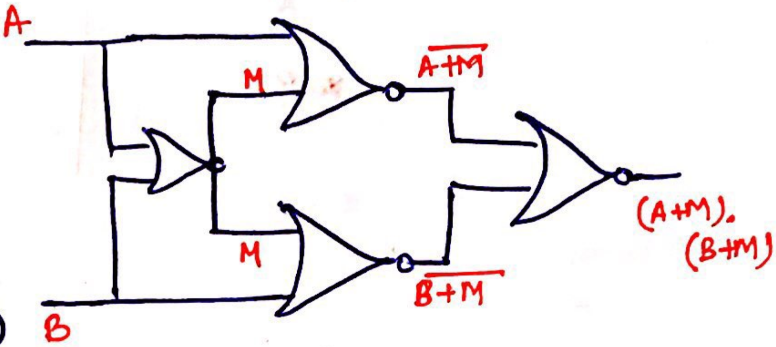
Q. Identify min. no. NOR gate required to realize 2-I/p X-NOR gate.

(a) 3 (b) 4 (c) 5 (d) None

$$Y = A \odot B$$
$$= \bar{A}\bar{B} + AB$$
$$= \underbrace{\overline{A+B}}_{M} + AB$$

1 NOR

$$= \underbrace{(M+A)(M+B)}_{3\,NOR}$$



	2 I/p NAND	2 I/p NOR
NOT	1	1
AND	2	3
OR	3	2
NOR	4	—
XOR	4	5
XNOR	5	4
NAND	—	4

Gate	Alternate gate
NAND	Bubbled OR
NOR	Bubbled AND
AND	Bubbled NOR
OR	Bubbled NAND

	NAND $(2n-2)$	NOR $(3n-3)$
$f_1 = AB$	2	3
$f_2 = ABC$	4	6
$f_3 = ABCDE$	8	12
$f_4 = A\overline{B}$	3 $(2+1)$	2 $(3-1)$
$f_5 = AB\overline{C}D\overline{E}$	10 $(8+2)$	10 $(12-2)$

complimen exception

	NAND $(3n-3)$	NOR $(2n-2)$	
$f_1 = A+B$	3	2	
$f_2 = A+B+C$	6	4	
$f_3 = A+B+C+D+E$	12	8	
$f_4 = A+\overline{B}$	$2(3-1)$	$3(2+1)$	compliment exception
$f_5 = A+B+\overline{C}+D+\overline{E}$	$10(12-2)$	$10(8+2)$	

Q. Identify whether the given boolean is a self dual function.

$$f(x,y,z) = \Sigma m(1,2,4,7)$$

consider for the function f, f_d is the dual function. if $(f_d = f)$ then function f is said to be self dual function.

$$f_d = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xyz$$

$$f_d = \overset{M_6}{(\bar{x}+\bar{y}+z)} \cdot \overset{M_5}{(\bar{x}+y+\bar{z})} \cdot \overset{M_3}{(x+\bar{y}+\bar{z})} \cdot \overset{M_0}{(x+y+z)}$$

$$= \pi(0,3,5,6)$$

$$= \Sigma(1,2,4,7) \quad \text{so, } \boxed{f_d = f}$$

Q. How many self dual functions are possible using 3 boolean variables.

(a) 8 (b) 16 ✓ (c) 32 (d) None

Total no. of minterm $= 2^n = 2^3 = 8$

so, there must be exact $2^n/2 = 8/2 = \underline{4 \text{ terms}}$

in a function to be a self-dual.

Mutally exclusive pairs for self dual

$0 \longleftrightarrow 7$

$1 \longleftrightarrow 6$

$2 \longleftrightarrow 5$

$3 \longleftrightarrow 4$

$\underbrace{(0,7)}_{\text{choose 1 from each pair}}, (1,6), (2,5), (3,4)$

so, we have total $2^n/2 = \underline{2^{n-1} \text{ pairs}} = m$

out of these pairs only 1 can be selected so, we have 2 choices for each pairs

Total no. of function possible $= 2^m$ where m is total pair possible

$= \left((2)^{2^{n-1}} \right)$ n is no. of boolean variable

OTE :- Netural function is the funcⁿ which has equal no. of minterms and maxterms.

For function to be a self dual function, it must be a netutral function.