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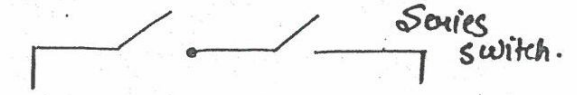
Boolean Algebra.

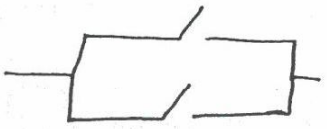
All variables → 5V.

1 → high / True.

0 → low / False.

↳ 0V / Ground

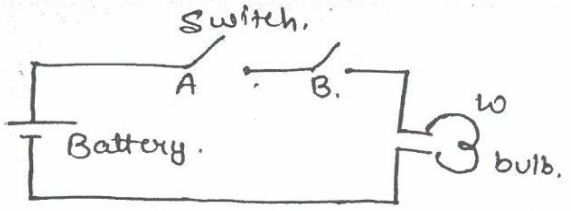




Operators.

AND GATE

A	B	W
0	0	0
0	1	0
1	0	0
1	1	1.



("AND Gate is Series Switch")

Truth table → Input / output Relationship.

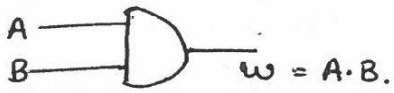
Ex:- AND from Set Theory.

X: {2, 3, 4}.

Y: {3, 5, 6}.

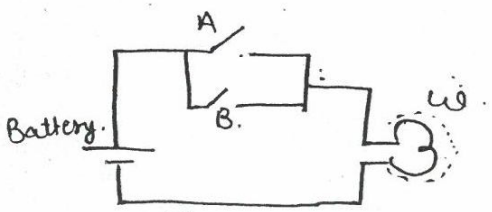
$(X \cap Y) = \{3\}$. ["$\cap$" → AND].

AND is generally $\cap$ intersection

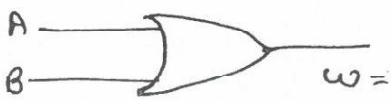


OR GATE

A	B	W.
0	0	0
0	1	1
1	0	1
1	1	1



("Parallel Switch.")

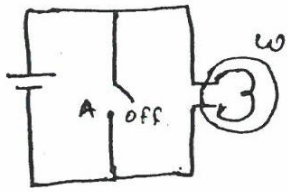


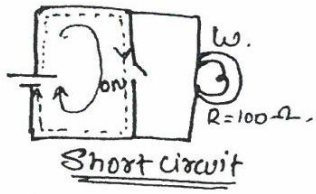
("+ = OR GATE")

From Set Theory.

$X \cup Y$ → OR gate.

NOT Gate / Inverter.





["current → 0 , Resistance = ∞"]

Current always flows from least resistance path.

[$\because V = IR$].

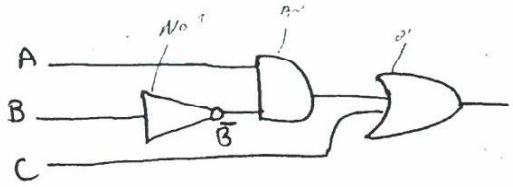
→ AND, OR, NOT gate are called Basic gates.

→ Presedence of operators ( ) > NOT > AND > OR

( )
NOT
AND
OR

Example :- $Y = A \cdot \bar{B} + C$.

1 → OR
& → AND.



AND properties.

1.) $X \cdot 0 = 0$.

2.) $X \cdot 1 = X$

3.) $X \cdot X = X$.

4.) $X \cdot \bar{X} = 0$.

OR properties.

1.) $X + 0 = X$.

2.) $X + 1 = 1$.

3.) $X + X = X$

4.) $X + \bar{X} = 1$.
0 1

Distributive Property :-

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

Ques Prove $(A+B) \cdot (A+C) = A + BC$.

Soln

$$A \cdot (A+C) + B \cdot (A+C).$$

$$A \cdot A + A \cdot C + B \cdot A + B \cdot C.$$

$$\Rightarrow A \cdot 1 + A \cdot C + B \cdot A + B \cdot C$$

$$\Rightarrow A(1 + \underbrace{C+B}_{x.}) + B \cdot C.$$

$$\Rightarrow A + B \cdot C. = R \cdot H \cdot S$$ Hence Proved.

Ques Prove $A + \bar{A}B = A + B$.

Soln

$$L \cdot H \cdot S = A + \bar{A}B.$$

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

$$So, (A+B)(A+\bar{A}).$$

$$\Rightarrow A + B = R \cdot H \cdot S$$

$\bar{A} + AB$

$AB.$

$A + \bar{A}B$

$A + B$

$A \cdot BC + A \cdot \bar{B}\bar{C} \cdot D.$

$A(BC + \bar{B}\bar{C} \cdot D)$

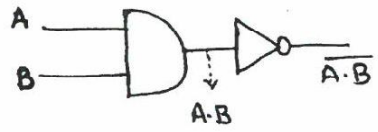
$A \cdot (B(+D).$

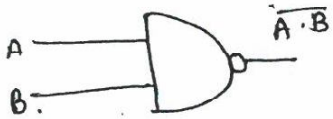
De Morgan's law.

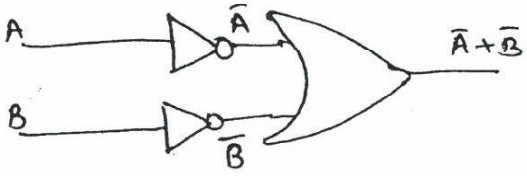
$$\overline{A+B} = \bar{A} \cdot \bar{B}$$

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

NAND GATE. (NOT of AND)

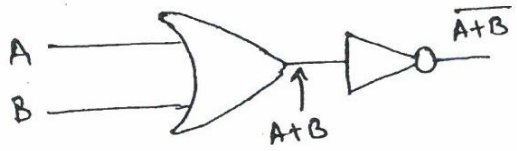


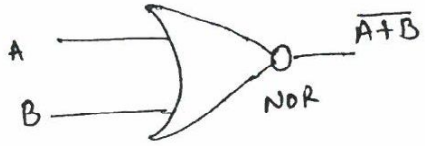


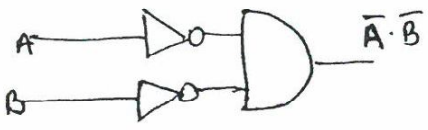


AB	A·B	$\overline{A \cdot B}$
0 0	0	1
0 1	0	1
1 0	0	1
1 1	1	0

NOR GATE (NOT of OR).







AB	A+B	$\overline{A+B}$
0 0	0	1
0 1	1	0
1 0	1	0
1 1	1	0.

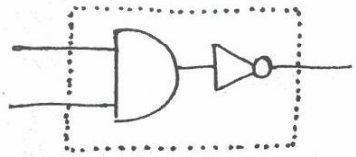
NOTE :- NAND Gate and NOR Gate are called Universal gates.

Universal / functionally Complete.

A logic circuit is said to be universal if any boolean function can be realised with instances of it.

Test :- Realise basic gates.

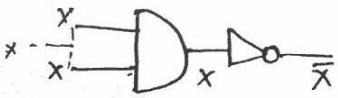
1.) Prove NAND gate is universal.



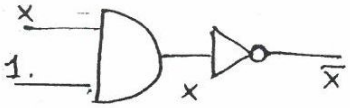
NOT Requirement

$X \cdot X = X$.

$X \cdot 1 = X$



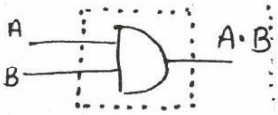
$X \cdot X = X$.



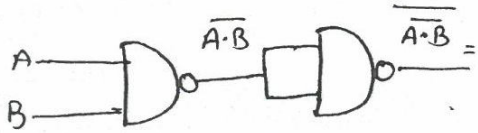
$X \cdot 1 = X$.

NAND Inverters.

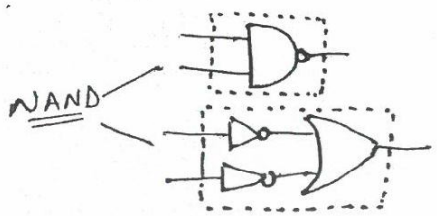
AND Requirement



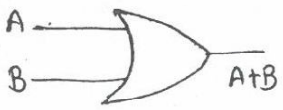
Requirement.



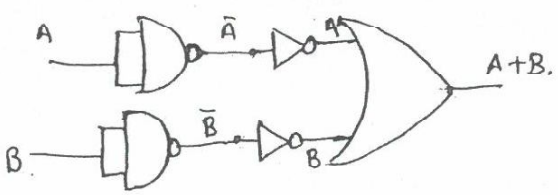
Result.



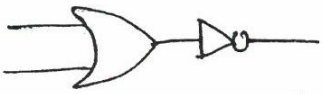
OR GATE Requirement :-



Requirement.

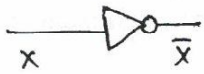


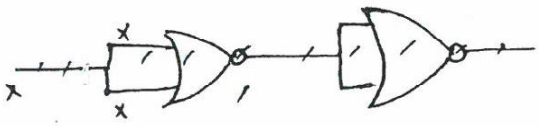
NOR GATE is universal :-



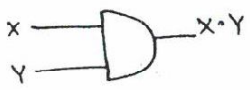
$X + X = X$, $X + 0 = X$.

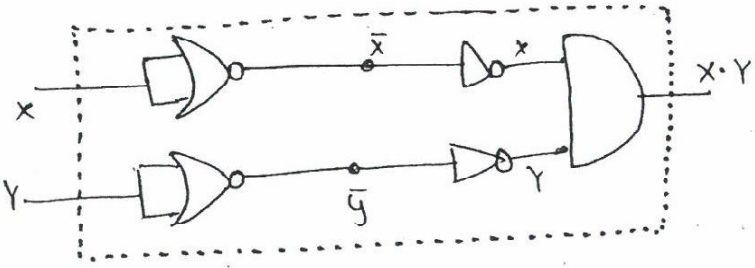
NOT gate :-





AND ~~OR~~ Gate.



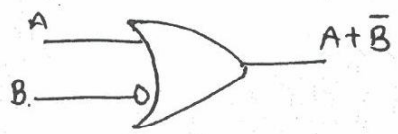


Ques Prove $A+\bar{B}$ universal

Assume Vcc and Ground available.

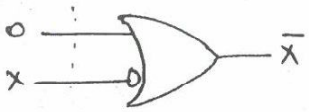
↓ 5V (1) ↓ 0V. (0).

Soln

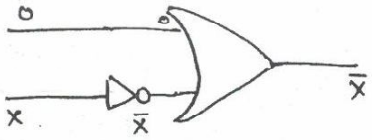


NOT

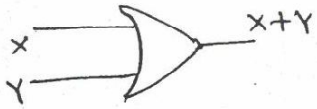
(Requirement).

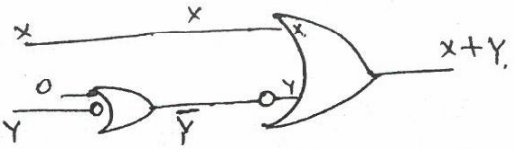


Available

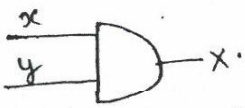


OR





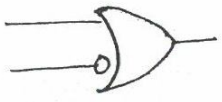
AND



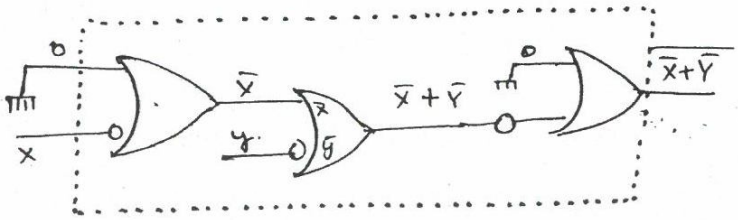
Requirement.

$\overline{X \cdot Y} = \bar{X} + \bar{Y}$

$\overline{\overline{X \cdot Y}} = \overline{\bar{X} + \bar{Y}}$



available.



$\{A+\bar{B}, 0\}$ is universal.

***
Ques Which of the following is Total function.

a.) $\{A \cdot B\}$

b.) $\{A+B, 0\}$

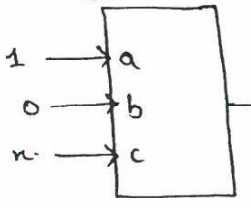
✓c.) $\{A \cdot \bar{B}, 1\}$.

d.) $\{A+B, 1\}$.

Ques Prove $f(a,b,c) = a\cdot\bar{c} + bc$ universal.

Soln

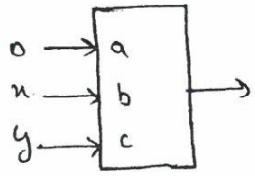
NOT



$\rightarrow f = a\cdot\bar{c} + b.c = \bar{x}$

$\boxed{f = \bar{c}}$

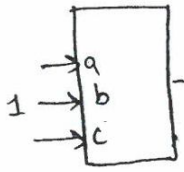
AND



$f = a\cdot\bar{b} + b.c$

$\boxed{f = b.c}$

DR



$f = a\cdot\bar{c} + b\cdot c$

$f = a\cdot\bar{c} + c \Rightarrow \boxed{a+c}$

Next Quiz Practice Consider the operations.

$$f(x,y,z) = \bar{x}yz + x\bar{y} + \bar{y}\bar{z}$$

$$g(x,y,z) = \bar{x}yz + \bar{x}y\bar{z} + xy.$$

Which of the following is functionally complete.