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Additional laws and theorem of Boolean Algebra :- Like ordinary algebra, Commutative, Associative & distributive laws are verified for Boolean Algebra.

- **Commutative laws** :- $A+B = B+A$
  $A \cdot B = B \cdot A$
- **Associative laws** :- $A+(B+C) = (A+B)+C$
  $A(BC) = (AB)C$.
- **Distributive laws** :- $A(B+C) = AB+AC$.

Other basic relations valid for Boolean Algebra

OR		AND	
$A+0 = A$	$A+A = A$	$A \cdot 0 = 0$	$A \cdot A = A$
$A+1 = 1$	$A+\bar{A} = 1$	$A \cdot 1 = A$	$A \cdot \bar{A} = 0$.

These two groups of law can be thought of in terms of OR and AND gates. Each of these identities can be proved, by substituting the two possible values of A i.e 0 and 1; on each side of the identity. In each case, the left-hand side will equal to the right-hand side. Again, the double-complement operation gives

$$\bar{\bar{A}} = A.$$

→ Some other useful theorem:-

(i). $A + AB = A$

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

(iii) $A(A+B) = A$

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

(v) $(A+B)(A+C) = A+BC$

(vi) $(A+B)(\bar{A}+C) = AC + \bar{A}B$.

putting the two values of 0 & 1; above identities can be proved:-

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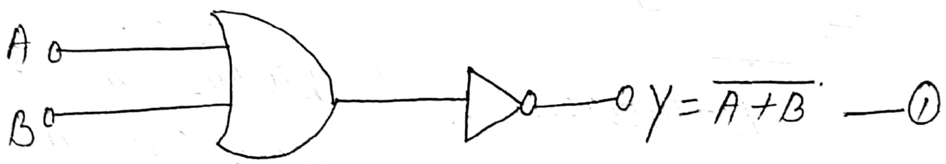
⇒ Circuit Representation of De-Morgon's first theorem :-

(a) NOR Gate (b) NAND Gate $(\bar{A} \cdot \bar{B})$.

De-Morgon's first theorem $\overline{A+B} = \bar{A} \cdot \bar{B}$; suggests that a logic system in which a NOT ckt. follows an OR gate and is called NOT-OR or NOR gate. (shown fig 4(a), (b)).



4(a). NOT-OR Gate

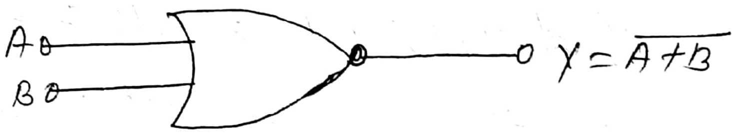


Fig 4(b) NOR-Gate

The truth table of two input NOR gate is given below :-

Input A	Input B	Output $Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

(b) This NOR-gate is also equivalent to a logic system in which the inputs to an AND gat are the outputs of two NOT-CKT shown in fig 4(c).

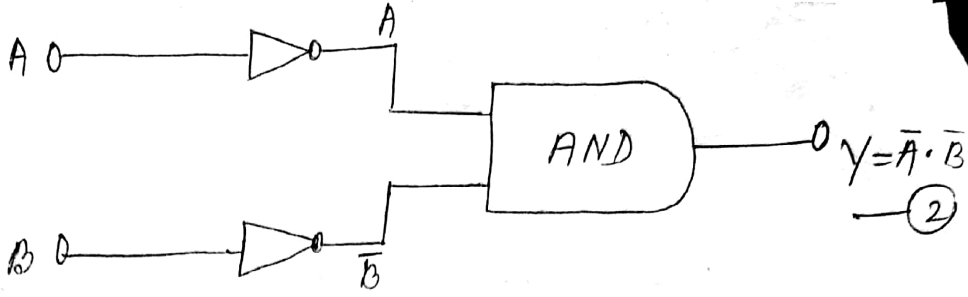


Fig- 4(c).

Here Fig. 4(a) & Fig 4(c) are the represent-ation of D.M. 1st theorem.

⇒ Circuit Representation of D.M. 2nd theorem.

D-Morgon's 2nd theorem is $\overline{A \cdot B} = \overline{A} + \overline{B}$ indicates that a logic system in which NOT ckt. follows an AND gate is called ~~Nand~~ NAND gate or NOT-AND gate. shown in fig. 5(a),(b) which is equivalent to a logic.

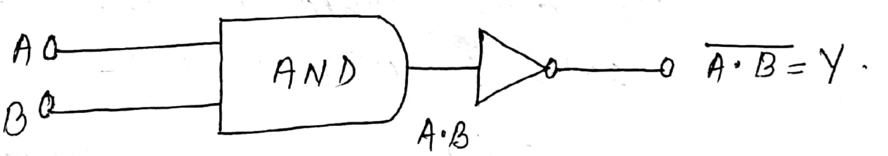


fig- 5(a).

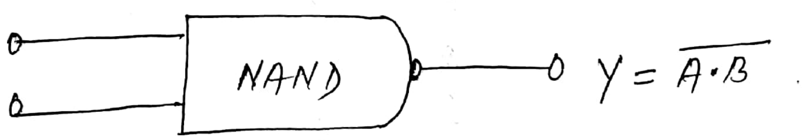


fig- 5(b).

System in which the inputs of an OR gates are the outputs from two NOT ckts [shown in fig. 5(c)]

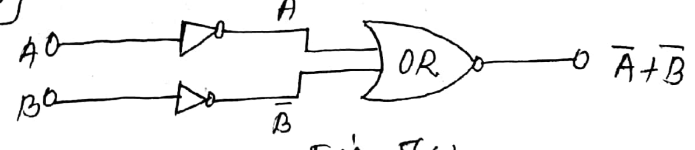


Fig. 5(c).

The truth table of NAND gate is shown below:-

Inputs A	Inputs B	outputs $Y = \overline{A \cdot B}$	Input	Input	output
0	0		1	0	1
0	1	1	1	1	0