

4. **NAND gate** :- The NAND gate is a popular logic element because it can be used as a universal gate , That is NAND gate can be used in combination to perform AND , OR and inverter operation .

The standard logic symbols is shown below :-



The logic expression is :-

$$x = \overline{A \cdot B}$$

The truth table is :-

I/P		O/P
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

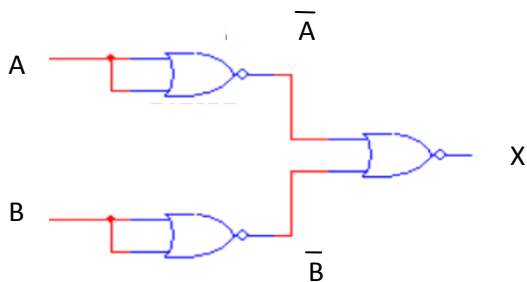
Construct NOT gate from NOR gate :-

1.



$$x = \overline{A}$$

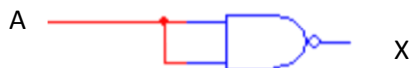
2. AND gate



$$x = \overline{\overline{A} + \overline{B}} = A.B$$

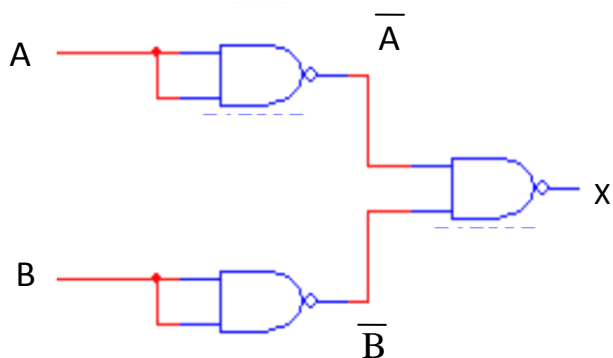
Construct NOT gate from NAND gate :-

1.



$$x = \overline{A.A} = \overline{A}$$

2. OR gate



$$x = \overline{\overline{A} . \overline{B}} = A+B$$

## **BOOLEAN OPERATION & EXPRESSIONS**

Boolean algebra is the mathematics of digital system. Variable, complement, and literal are terms used in Boolean algebra

### **Law of Boolean algebra**

The basic law of Boolean algebra \_ The commutative laws for addition and multiplication, The associative law for addition and multiplication, and distributive law.

**1. Commutative Law:-** The commutative law of addition for two variables is written as :

$$\mathbf{A + B = B + A}$$

The commutative Law of multiplication is :-

$$\mathbf{A . B = B . A}$$

**2. Associative Law:-** The associative law of addition is written as :

$$\mathbf{A + (B+C) = (A+ B )+C}$$

The associative Law of multiplication is :-

$$\mathbf{A (BC) = (AB)C}$$

**3. Distributive Law:-** The distributive Law is written for three variables as follows:

$$A (B+C) = AB+AC$$

**Rules of Boolean algebra:-**

1.  $A + 0 = A$

2.  $A + 1 = 1$

3.  $A \cdot 0 = 0$

4.  $A \cdot 1 = A$

5.  $A + A = A$

6.  $A + \bar{A} = 1$

7.  $A \cdot A = A$

8.  $A \cdot \bar{A} = 0$

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

10.  $A + AB = A (1 + B) = A \cdot 1 = A$

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

## De Morgan's Theorem:-

De Morgan's theorem , proposed two theorems that are important part of Boolean algebra .

1- The complement of a product of variables is equal to the sum of complement of the variables .

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

2- The complement of a sum of variables is equal to the product of complement of the variables .

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

Example 1

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

$$AA+AC+AB+BC$$

$$A+AC+AB+BC$$

$$A(1+C)+AB+BC$$

$$A+AB+BC$$

$$A(1+B)+BC$$

$$A+BC$$