BOOLEAN ALGEBRA

Boolean Algebra is used to analyze and simplify the digital *logic* circuits. It uses only the binary numbers i.e. 0 and 1. It is also called as **Binary Algebra** or **logical Algebra**. Boolean algebra was invented by **George Boole** in 1854.

Rule in Boolean Algebra

Following are the important rules used in Boolean algebra.

- Variable used can have only two values. Binary 1 for HIGH and Binary 0 for LOW.
- Complement of a variable is represented by an overbar −. Thus, complement of variable B is represented as $\overline{B}$ = 0.
- ORing of the variables is represented by a plus + sign between them. For example ORing of A, B, C is represented as A + B + C.
- Logical ANDing of the two or more variable is represented by writing a dot between them such as A.B.C. Sometime the dot may be omitted like ABC.

Boolean Laws

There are six types of Boolean Laws.

Commutative law

Any binary operation which satisfies the following expression is referred to as commutative operation.

$$\text{(i) } A.B = B.A \qquad \text{(ii) } A + B = B + A$$

Commutative law states that changing the sequence of the variables does not have any effect on the output of a logic circuit.

Associative law

This law states that the order in which the logic operations are performed is irrelevant as their effect is the same.

$$\text{(i) } (A.B).C = A.(B.C) \qquad \text{(ii) } (A + B) + C = A + (B + C)$$

Distributive law

Distributive law states the following condition.

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

AND law

These laws use the AND operation. Therefore they are called as **AND** laws.

$$\text{(i) } A.0 = 0 \qquad \text{(ii) } A.1 = A$$

$$\text{(iii) } A.A = A \qquad \text{(iv) } A.\overline{A} = 0$$

OR law

These laws use the OR operation. Therefore they are called as **OR** laws.

$$(i)\ A + 0 = A \qquad (ii)\ A + 1 = 1$$

$$(iii)\ A + A = A \qquad (iv)\ A + \overline{A} = 1$$

INVERSION law

This law uses the NOT operation. The inversion law states that double inversion of a variable results in the original variable itself.

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

Important Boolean Theorems

Following are few important boolean Theorems.

Boolean function/theorems	Description
Boolean Functions	Boolean Functions and Expressions, K-Map and NAND Gates realization
De Morgan's Theorems	De Morgan's Theorem 1 and Theorem 2