# Introduction to Boolean Algebra

It is a special type of Algebra in which variable (Boolean Variable) can only take 2 values ie 0 or 1

$$x \longrightarrow \begin{cases} 0 \to F \to \emptyset \to X & Or \\ 1 - T \to \cup \to \checkmark & 5v \end{cases} \Bigg] \text{+ve} \atop \text{logic system}$$

| $x$ | $y$ | | |
|-----|-----|---|---|
| 0 | 0 | $\to$ | $\bar{x}\, \bar{y}$ |
| 0 | 1 | $\to$ | $\bar{x}\, y$ |
| 1 | 0 | $\to$ | $x\, \bar{y}$ |
| 1 | 1 | $\to$ | $x\, y$ |

$\to$ minterm or Boolean term

It is atomic in nature it cannot be further subdivided

In minterm every boolean variable must be present.

n boolean variable can have $= 2^n$ minterms

* ## Boolean function
Any combination of boolean terms.

if we have two boolean variable we can make $= 2^4 \to y_{c_0} + y_{c_1} + y_{c_2} + y_{c_3} + y_{c_4}$ function

$$n_{c_0} + n_{c_1} + n_{c_2} + n_{c_3} \cdots n_{c_n} \to 2^n$$

Q If we've 3 boolean variables then how
many boolean function have 2 minterms?

A $8c2 \implies 2^3 \implies 8 \implies {}^8c_2$ __Ans__

Q If we have n boolean variables the how
many boolean function have x minterm

A $2^{n}c_n$ __Ans__ $\rightarrow$ generalize formula

* Gate Question

○ we have 4 boolean variables how many
functions are possible?

$2^4 \implies 2^{16}$ $2^4 \implies$ 16 minterms

$2^{16} \implies$ boolean function

$2^{16}$ __Ans__ $\implies 2^{(2^4)}$ __Ans__

○ if n boolean [term] or minterm how many
boolean function

a) $2^n$ ✓  because asked boolean "terms"
b) $2^{2^n}$   if variable the ans should be
c) $2^{n/2}$   $2^{2^n}$
d) no

## 2 boolean variable

$$2^{2^2} \Rightarrow \boxed{16} \rightarrow \text{ we have 7 famous function}$$
that we implement through gate

| | | | |
|---|---|---|---|
| ① | $f_1(x) = \bar{x}$ | $\longrightarrow$ | Not |
| 2 | $f_2(x,y) = xy$ | $\longrightarrow$ | AND |
| 3 | $f_3(x,y) = \bar{x}y + x\bar{y} + xy$ | $\longrightarrow$ | OR |
| 4 | $f_4(x,y) = \bar{x}y + x\bar{y}$ | $\longrightarrow$ | XOR |
| 5 | $f_5(x,y) = \bar{x}\bar{y} + xy$ | $\longrightarrow$ | XNOR |
| 6 | $f_6(x,y) = \bar{x}\bar{y} + \bar{x}y + x\bar{y}$ | $\longrightarrow$ | NAND |
| 7 | $f_7(x,y) = \bar{x}\bar{y}$ | $\longrightarrow$ | NOR |

## Truth table form

| | $x$ $y$ | $f_1$ | $f_2$ | $f_3$ | $f_4$ | $f_5$ | $f_6$ | $f_7$ |
|---|---|---|---|---|---|---|---|---|
| $\bar{x}\bar{y}$ | 0 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| $\bar{x}y$ | 0 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| $x\bar{y}$ | 1 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| $xy$ | 1 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| | | Not | AND | OR | XOR | XNOR | NAND | Nor |

opposite of each other