Logic Gates.

- logic gates is an electronic circuit that operates on one- or more signals to produce standard output signals.
- It is a digital circuit with one or more input signal but only one output signals.

Logic Gate
- High (1) → ON
- low (0) → off

- Logic gates allows the signals to pass through only when some logic conditions are satisfied.
- logic gate can has only one output signal
- Logic gates are indicated by the :-

  ⊳ Symbol
  ⊳ Truth Table
  ⊳ Boolean Algebra.

Types of logic Gates

Logic Gates
- Basic logic Gates
  - ND
  - OR
  - NOT
- Combinational logic Gates
  - Exclusive OR
  - Exclusive NOR
- Universal logic Gat
  - NAND
  - NO

(Combination of logic Gat

Basic Logic Gates

The basic logic gates are:-

(1) AND gate
(2) OR gate
(3) NOT gate

Notes by :- Ipwebdevelopers.in

(1) AND Gate :-

- A circuit which performs an AND operation.
- It has n input (Two or more than 2) (n>=2), and one output
- Output :- The output of AND gate is high (1) when all the inputs are high (1).
- Multiplication symbol used for ordinary arithmetic.
- Algebraic function of AND Gate

$X = A \text{ AND } B$ (Where A, B are Inputs X is output).

$= A \cdot B$

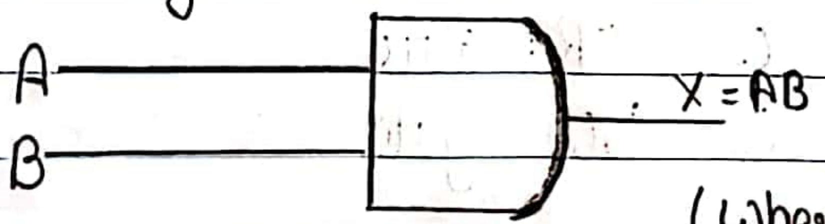
$= AB$

$= A \cap B$

- Truth Table of AND Gate with Two Inputs

Inputs		Output
A	B	X (AB)
0	0	0
0	1	0
1	0	0
1	1	1

- Logic Diagram (Graphic Symbol) for AND Gate



(Where A, B are Input X is output)

(2) OR Gate :-

- A circuit which performs OR operation.
- It has n input ($n >= 2$) and one output.
- Output :- The output of OR gate is high (i.e. 1) when if one or more inputs are high (i.e. 1)

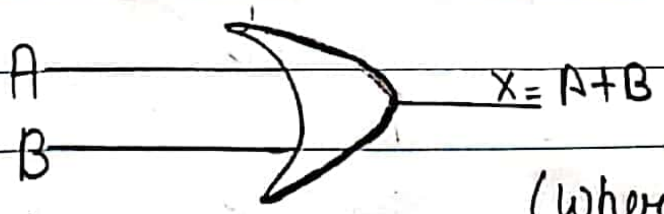
- Addition symbol used for ordinary arithmetic.
- Algebraic function of OR gate :-

X = A OR B (Where A, B are inputs X is output)
= A + B
= A ∪ B
= A ∨ B

- Truth Table of OR gate with Two Inputs.

Inputs		Output
A	B	X (A+B)
0	0	0
0	1	1
1	0	1
1	1	1

- Logic Diagram



(where A, B are Input X is output)

(3) Not gate / Inverter :-

- Not gate is also known as Inverter.
- It has one Input and one output.

- The output of NOT gate is high, when Input is low (0).

- Algebraic function of NOT gate.

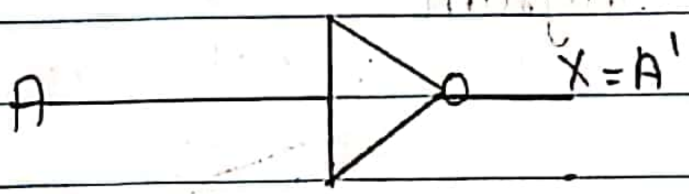
$$X = A'$$
$$= \bar{A}$$
$$= NOT\ A$$

(A is variable, X is output).

- Truth Table

Input A	Output X
0	1
1	0

- logic Diagram



(Where A is Input, X is output)

* NAND and NOR (Combination of logic Gates and Universal Gates).

(4) **NAND Gate** :- It is a combination of AND or NOT gate.

The NOT-AND operation is known as NAND operation.
It has n input (n >= 2) and one output.
Algebraic function of NAND Gate

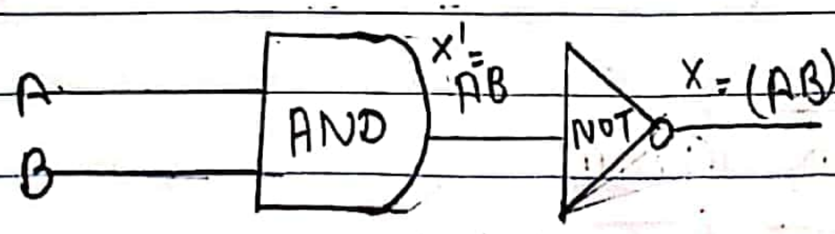
$$X = A \text{ NAND } B$$
$$= (AB)'$$
$$= A \uparrow B$$

Truth Table

Inputs			Output
A	B	AB	X = (AB)'
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

(Output is low when both the I/P are high)

Logic Diagram



NAND Gate :
Symbol

(5) **NOR Gate :-** It is combination of OR and NOT Gate.

A NOT-OR operation is also known as NOR operation.

It has n input ($n \geq 2$) and one output. (output is high when both I/p are low).

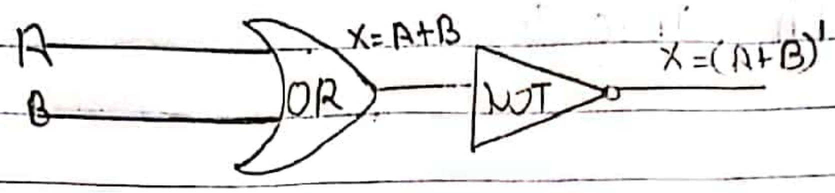
Algebric function of NOR Gate

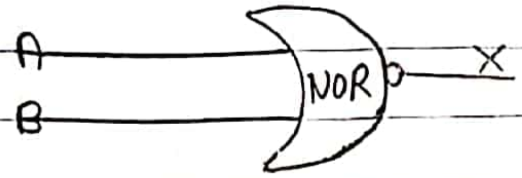
$$X = A \text{ NOR } B$$
$$= (A+B)'$$
$$= A \downarrow B$$

Truth Table

Inputs			Output
A	B	A+B	(A+B)'
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Logic Diagram





⊛ XOR and XNOR Gates.

(6) Exclusive - OR (X-OR) Gate

- XOR or EX-OR gate is a special type of gate.
- The exclusive-OR gate is abbreviated as EX-OR gate or X-OR gate.

- It has n inputs ($n >= 2$) and one output.

- The output of XOR Gate is high, when Inputs are not same (one of them is 0 and other one is 1).

Algebric function of XOR Gate:-

$$X = A \text{ XOR } B$$
$$= A \oplus B$$
$$= A'B + AB'$$

Truth Table :-

Inputs		Output
A	B	$X = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Logic Diagram :-

(7) EX-NOR Gate (Exclusive-NOR)

It is logical Complement of XOR Gate.

It is a special type of gate. The exclusive-NOR gate is abbreviated as EX-NOR gate or X-NOR gate.

It has n inputs (n>=2) and one output.

The output is high (1), when both Inputs 0 or both 1.

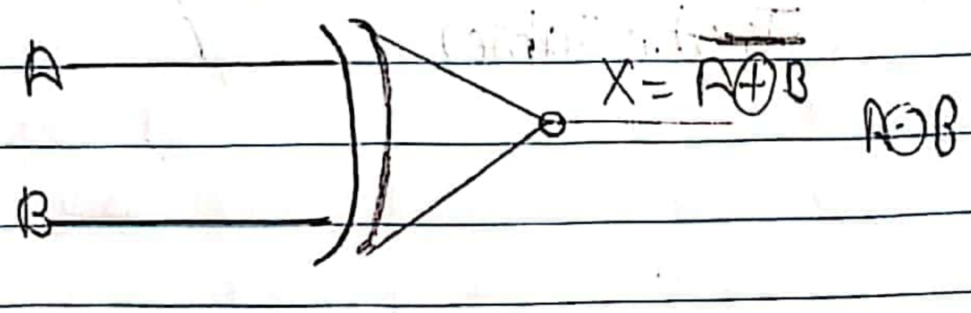
Algebraic Function of Exclusive-NOR

$$X = A \text{ EX-NOR } B$$
$$= A \odot B$$
$$= A'B' + AB$$
$$= \overline{A \oplus B}$$

Truth Table

Inputs			Output
A	B	$A \oplus B$	$\overline{A \oplus B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Logic Diagram



Universal Gates

NAND & NOR as Universal Grates.

Universal Gates :- The gates that can perform all the basic logical operations (AND, OR, NOT) are such Universal Gates.

Universal gate is a logic gate which can implement any Boolen function without the need to use any other type of logic gate.
(किसी भी Type के Boolen function को Implement करने के काम आते है)

➤ NAND Grate as Universal Grate

NAND Gate can be used to represent other basic logic gates.

(i) Implementation of NOT Gate Using NAND Gate
(Truth Table) → Combination of multiplication and its complement

A	B	X = A'
0	0	1
0	1	1
1	0	1
1	1	0

AND → multiplication
NOT → complement

(output is low, when both I/P are high)

(Logic Diagram):

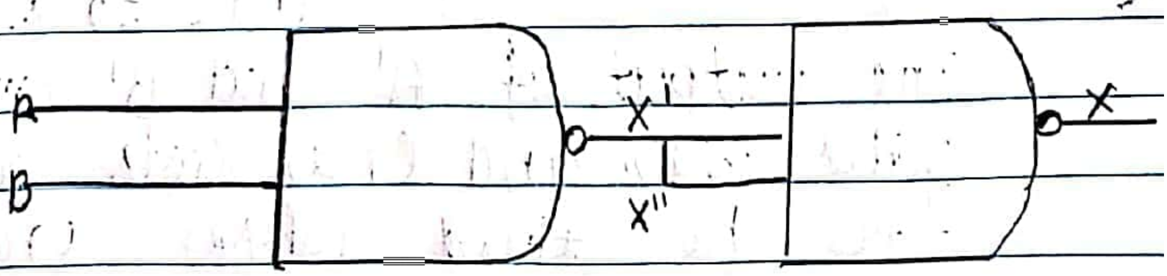
(ii) Implementation of AND Gate Using NAND Gate

$X = ((AB)')'$
$= AB$

Truth Table

A	B	X'	X''	X (AB)
0	0	1	1	0
0	1	1	1	0
1	0	1	1	0
1	1	0	0	1

Logic Diagram



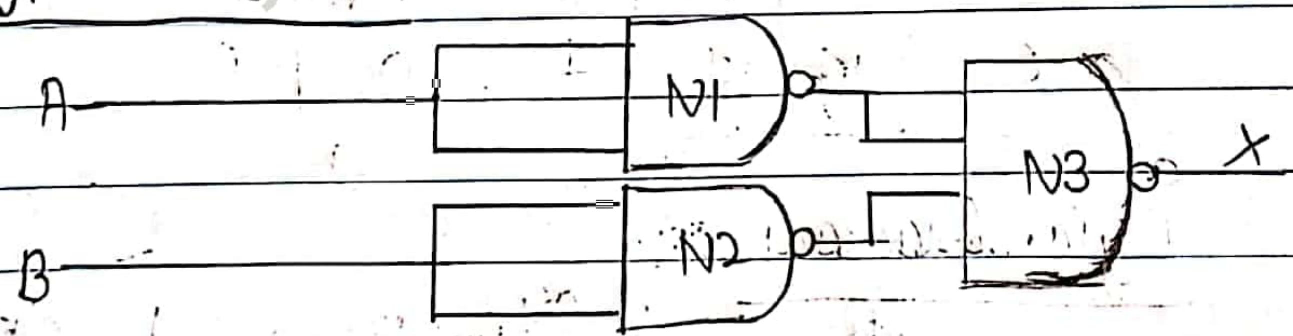
(iii) Implementation of OR Gate using NAND Gate

$$X = (A' \cdot B')'$$
$$= (A')' + (B')' \quad \text{(De morgen's theorm)}$$
$$= A + B$$

Truth Table.

A	B	(OR)	(NAND) X
0	0	0	1
0	1	1	1
1	0	1	1
1	1	1	0

Logic Diagram



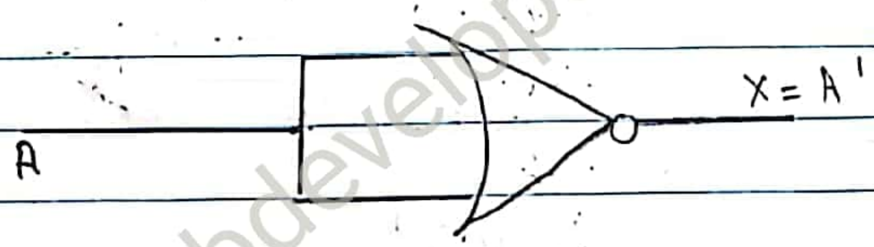
The output of A' and B' from the gates (N1) and (N2) acts as inputs to the third NAND Gate (N3).

➢ NOR Gate as Universal Gate

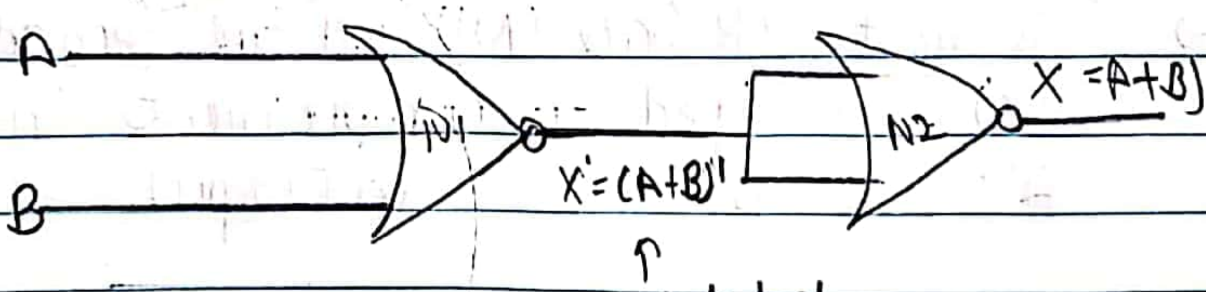
NOR Gate can be used to represent other basic Gates.

(i) Implementation of NOT Gate using NOR gate: (work as Invertor gate).

$$X = A'$$
$$(A+A)' = A'$$



(ii) Implementation of OR gate using NOR gat



(Boolen Expression)

$$X' = (A+B)'$$
$$X = (X')'$$
$$= (\overline{A+B})' \quad \therefore \text{De morgen's law}$$
$$= A+B$$

$(\bar{A} \cdot \bar{B})$

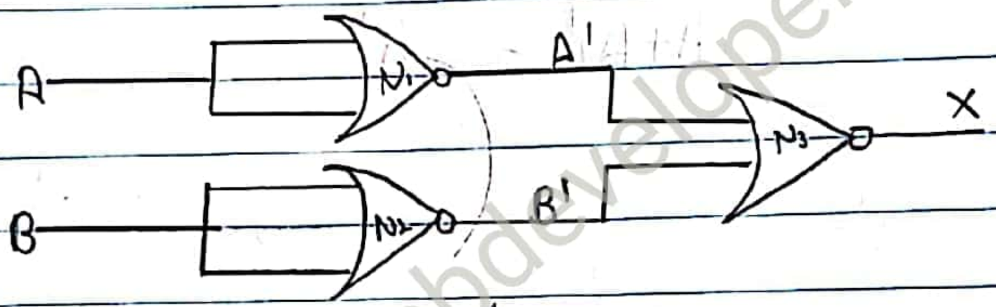
⇓

$A+B$.

→ The first NOR gate (N1) has two inputs A and B and the output is $(A+B)'$

→ The second NOR gate (N2) has $(A+B)'$ as an Input from the first NOR gate (N1) Output.

(iii) Implementation of AND gate using NOR gate



$X = (A' + B')'$
$= (A')' \cdot (B')'$ ∴ De morgen's law
$= A \cdot B$
AB

→ The first NOR Gate (N1) and the second NOR Gat (N2) are used to complement the input A' and B' as an output

→ The output A' and B' from the gate (N1) and (N2) act as input to third NOR gate (N3).

* Applications of Logic Gates.

- The applications of logic Gates are:-
- NAND Gates are used in buzzars and burglar alarms.
- They are basically used in push button switches. E.g. Door Bell.
- They are used in the functioning of Street lights.
- Security Purpose.
- logic gates are quick yet use low energy
- AND Gates are used as Enable gate and inhibit gate.
  - → Enable gate means acceptance of data through a pathway.
  - → Inhibit gate is the opposite of that process which means rejection of data through a pathway.