Logic Gates

Logic gates are basic building blocks of digital circuits that perform logical operations on one or more binary inputs to produce a single binary output.

Each gate implements a specific logic function, such as **AND**, **OR**, **NOT**, **NAND**, **NOR**, **XOR**, or **XNOR**, which determines how the output is derived from the inputs.

These gates are used in various combinations to perform complex computational tasks in electronic devices.

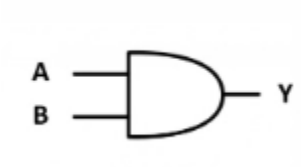
1) AND GATE

Definition:
An AND gate is a digital logic gate that outputs a 1 (true) only if all of its inputs are 1 (true). If any input is 0 (false), the output will be 0 (false).

Boolean expression:
Y = A . B

Logic symbol: ^

Logical diagram:



Truth Table:

Inputs		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

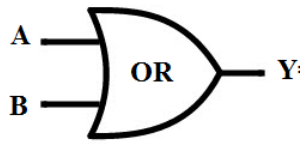
2) OR GATE

Definition:
An OR gate is a digital logic gate that outputs true (1) if at least one of its inputs is true (1). If all inputs are false (0), the output is false (0).

Boolean expression:
Y = A + B

Logic symbol: ˅

Logical diagram:



Truth table:

Inputs		Output
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

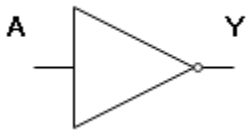
3) NOT GATE

Definition:
A NOT gate, also known as an inverter, is a logic gate that takes a single binary input and produces the opposite binary output. If the input is 0, the output is 1; if the input is 1, the output is 0.

Boolean expression:
Y = NOT A

Logic symbol: ~

Logical diagram:



Truth table:

Truth Table	
A	A'
1	0
0	1

4) NAND GATE

Definition:

- A **NAND** gate is a type of logic gate that produces an output which is false only if all its inputs are true; otherwise, the output is true.
- It is the inverse of the **AND** gate.
- It combines the functions of an **AND** gate followed by a **NOT** gate.
- In binary terms, if the inputs are both 1 (true), the output is 0 (false); for any other combination of inputs, the output is 1 (true).

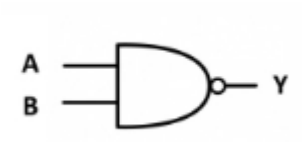
Boolean Expression:

$$Y = \overline{A.B}$$

Or , Y = **NOT**(A.B)

Logic symbol: (same as AND gate with a circle at the output)

Logical diagram:



Truth table:

Inputs		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

5) NOR GATE

Definition:

- A **NOR** gate is a type of logic gate that produces an output which is false (0) if at least one of its inputs is true (1).
- - In other words, it gives a true (1) output only when all of its inputs are false (0).
- It is the inverse of the **OR** gate.
- It is the combination of an **OR** gate followed by a **NOT** gate.

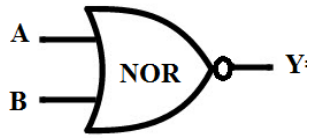
Boolean expression:

$$Y=\overline{A+B}$$ **or,**

Y= **NOT** (A+B)

Logic symbol: (same as OR gate with a circle at the output)

Logical diagram:



Truth table:

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

6) X-OR GATE

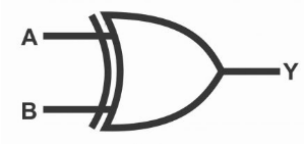
Definition:

- An **XOR** (exclusive **OR**) gate is a digital logic gate that outputs true or 1 only when the number of true or 1 inputs is odd.
- For a two-input **XOR** gate, it outputs 1 if exactly one of the inputs is 1, and 0 if both inputs are the same (both 0 or both 1).
- In simpler terms, it outputs 1 when the inputs are different and 0 when they are the same.

Boolean expression:

$A \oplus B = A\overline{B} + \overline{A}B$ **! important**

Logical diagram:



Logic symbol: ⊕

Truth table:

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Note: if input(A,B) are same output: 0, otherwise:1

7) X-NOR GATE

Definition:

- An **X-NOR** gate (exclusive **NOR** gate) is a type of logic gate that outputs true (1) only when the number of true inputs is even.

- In simpler terms, for two inputs, an **X-NOR** gate outputs true (1) if both inputs are the same (both 0 or both 1) and false (0) if the inputs are different (one 0 and one 1).
- It is the opposite of an **X-OR** gate.

Boolean expression:

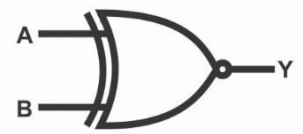
$$Y = (\overline{A \oplus B}) = (A.B + \overline{A}.\overline{B})$$

! Important

Y= A ⊙ B

Logic symbol: ⊙

Logical diagram:

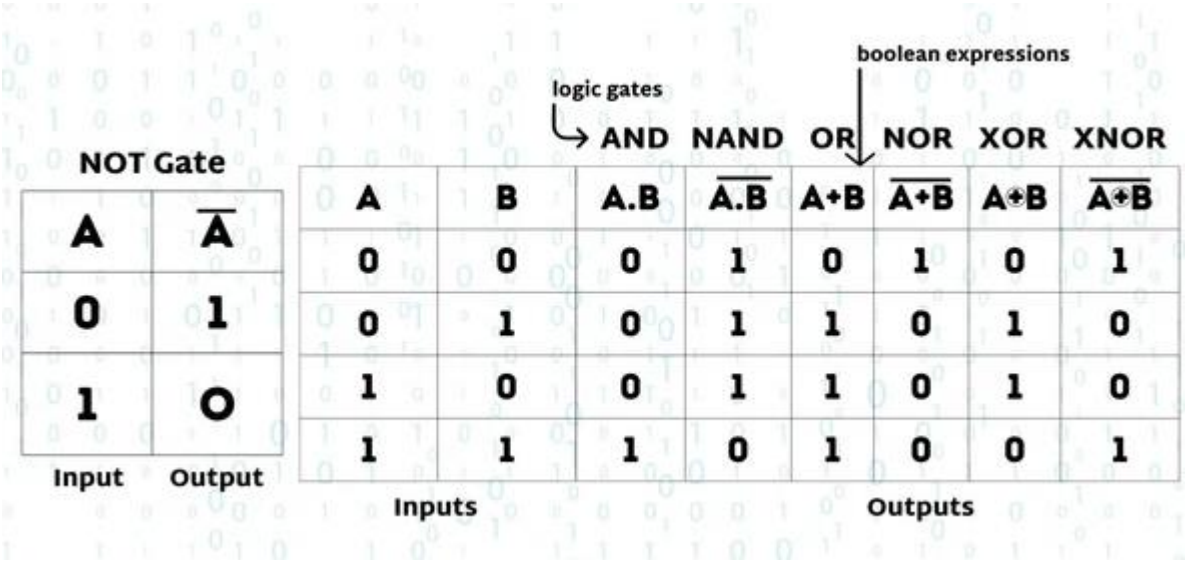


Truth table:

A	B	Output
0	0	1
1	0	0
0	1	0
1	1	1

Note: if input(A,B) are different output:0, otherwise 1

Summary:



THESE LOGIC GATES ARE COMBINED TO FORM MORE COMPLEX CIRCUITS, SUCH AS ADDER, MULTIPLEXER AND FLIPFLOP, WHICH ARE THE BUILDING BLOCKS OF DIGITAL COMPUTERS

THANK YOU !