ELECTRONIC PRINCIPLES AND DEVICES

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Unit-3 Digital Electronics

Boolean Algebra and Logic gates

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Boolean Algebra and Logic gates

- Digital Electronic circuits process data that contains **binary values 1's and 0's.**
- A **Logic "1"** is also referred as HIGH voltage or TRUE or ON state
- A **Logic "0"** is also referred as LOW voltage or FALSE or OFF state
- A binary digit "0" or "1" is called a **bit**
- Digital information is stored using a series of binary values 1's and 0's.
- Digital systems such as digital telephones, digital cameras, computers, handheld portable devices and other high technology systems **stores and process** these binary values (1's and 0's)

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Boolean Algebra and Logic gates

❖ Boolean Algebra is the mathematics used to analyse and **simplify logic or digital circuits**.

❖ Digital circuits are constructed by using **logic gates**.

❖ Logic gates are the basic building blocks of digital systems, performs logical functions based on Boolean algebra.

❖ Logic gates have one or more inputs and only one output.

❖ Number of possible input states is **$2^{\wedge n}$**. Where n is Number of inputs

❖ Logic gates are implemented using diodes or transistors which acts as electronic switches

❖ logic gates **: (i) Basic Gates:** AND, OR, NOT,
(ii) Derived Gates: NAND, NOR, EXOR and EXNOR gates

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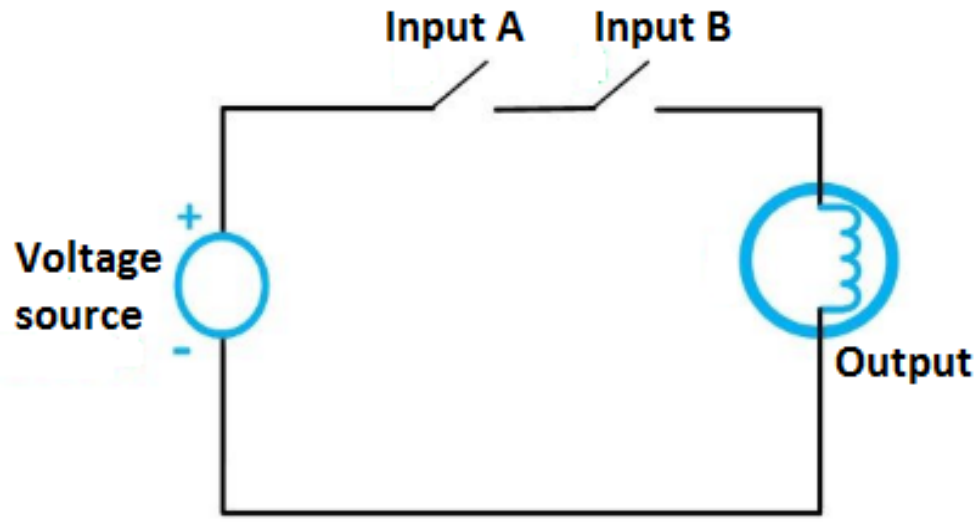
Boolean Algebra and Logic gates

❖ **AND Gate** is an electronic circuit that gives output as logic “1” (HIGH) only if all inputs are “1”. Otherwise output is Logic “0” (LOW)

❖ Boolean algebra representation for AND gate is **Y = A.B**

❖ AND gate is represented as **series connection** of two switches

Symbol



Truth Table

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

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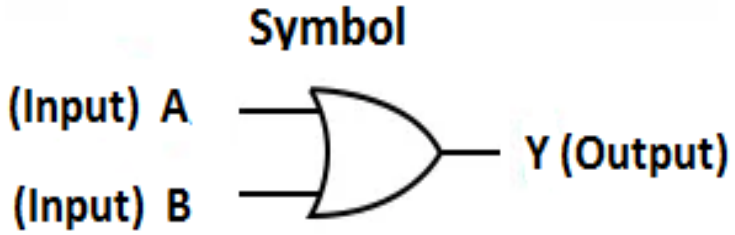
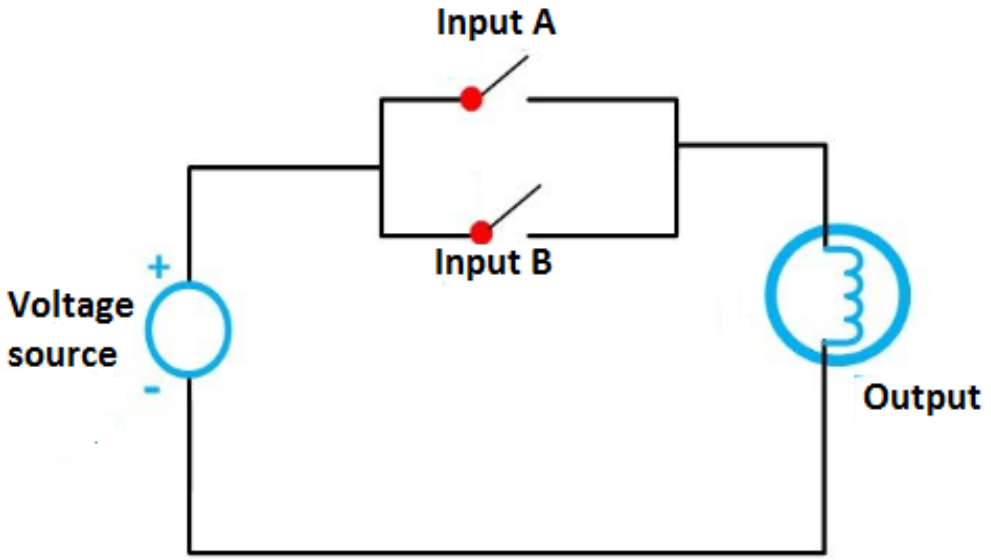
Boolean Algebra and Logic gates

❖ **OR Gate** is an electronic circuit that gives as Logic “1” (HIGH) if any of the inputs are HIGH .Output of OR gate goes Logic “0” (LOW) only if all inputs are Logic “0” (LOW)

❖ Boolean algebra representation of OR gate is Y = A + B

❖ OR gate is represented as **parallel connection** of two switches





Truth Table

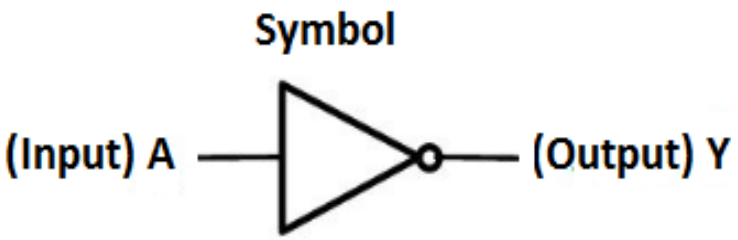
Inputs		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

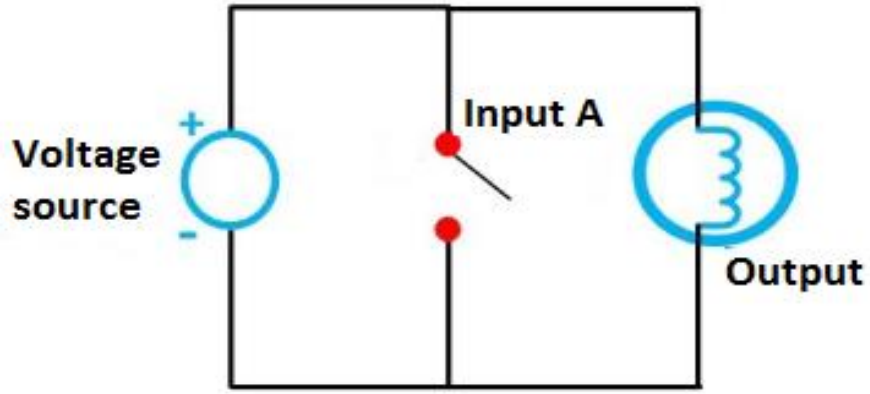
Boolean Algebra and Logic gates

❖ **NOT Gate** is a single input and single output gate which performs the inversion of the applied binary input signal. Hence it is also called as Inverter Gate.

❖ Boolean expression for NOT gate is $Y = \overline{A}$

❖ NOT Gate can be represented by connecting a switch parallel to bulb





Truth Table

Input	Output
A	Y
0	1
1	0

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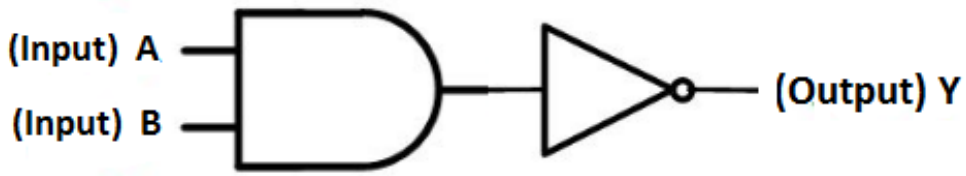
Boolean Algebra and Logic gates

NAND Gate

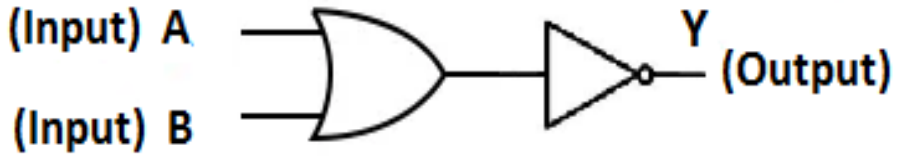


Symbol

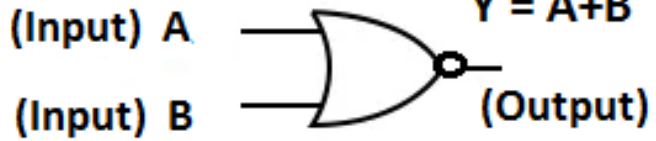
Truth Table

NAND		
Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate



Symbol



Truth Table

NOR		
Input		Output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

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Boolean Algebra and Logic gates

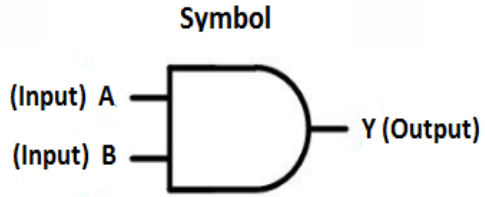
❖ Logical Boolean Laws:

❖ NOT / Inversion Law:

$$\overline{1} = 0$$
$$\overline{0} = 1$$

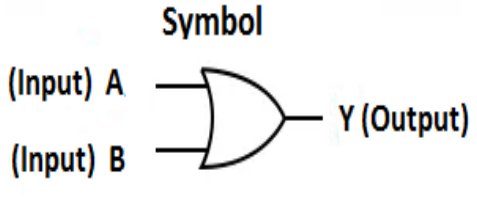
(i) If A = 1 then A' = 0 and if A = 0 then A' = 1
(ii) (A')' = A itself

❖ AND Law:



0.0 = 0	A.0 = 0
0.1 = 0	A.1 = A
1.0 = 0	A.A = A
1.1 = 1	A.A' = 0

❖ OR Law:



0+0 = 0	A+0 = A
0+1 = 1	A+1 = 1
1+0 = 1	A+A = A
1+1 = 1	A+A' = 1

❖ Principle of duality in Boolean Algebra

❖ In Boolean Algebra , One type of expression can be converted into another type of expression by replacing "0 with 1 " , " 1 with 0" , "(+) sign with (.) sign " and vice versa.

AND (.)	OR (+)
0.0 = 0	1+1 = 1
0.1 = 0	1+0 = 1
1.0 = 0	0+1 = 1
1.1 = 1	0+0 =0

Example:

Expression	Dual Expression
$\overline{0} = 1$	$\overline{1} = 0$
0.1 = 0	1 + 0 = 1
A.0 = 0	A + 1 = 1
A.B = B. A	A + B = B + A
$A.\overline{A} = 0$	$A + \overline{A} = 1$

THANK YOU

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