LOGIC GATES

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Logic Gate:

A digital electronic circuit that has one or more inputs and a single output.

Basic Logic Gates:

OR, AND and NOT gates.

Using these gates, one can construct any type of digital system.

Since they use binary logic,they can have only HIGH (1) or LOW (0) states.

Truth table

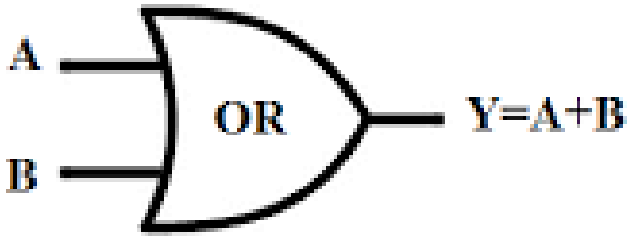
A tabular representation of the various input logic levels and the possible output logic levels of a gate.

It represents the complete behaviour of the gate circuit.

OR GATE

Digital electronic circuit with 2 or more inputs but only 1 output.

It is called so because the output is high if any or all of the inputs are high.



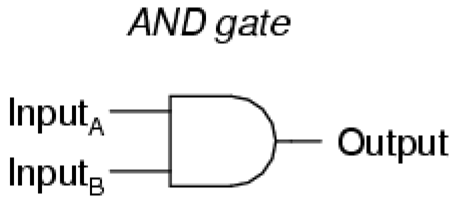
Inputs		Output
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

AND GATE

Digital electronic circuit with two or more inputs and only one output.

It is called so because the output is high only if all the inputs are high.

Output Y=A.B

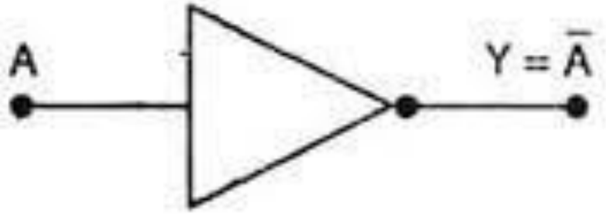


A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

NOT GATE

Digital gate circuit that has one input and one output.

It is called so because the output is always the opposite of the input.



(a)

A	Y
0	1
1	0

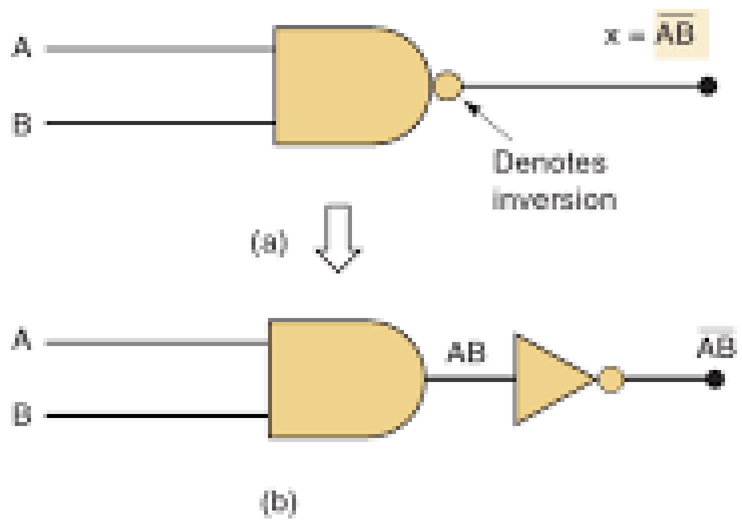
(b)

FIG 15-5: **(*a*) Circuit symbol of a NOT gate,**
(*b*) Truth table for a NOT gate.

COMBINATION OF BASIC GATES

NAND GATE

AND gate followed by NOT gate

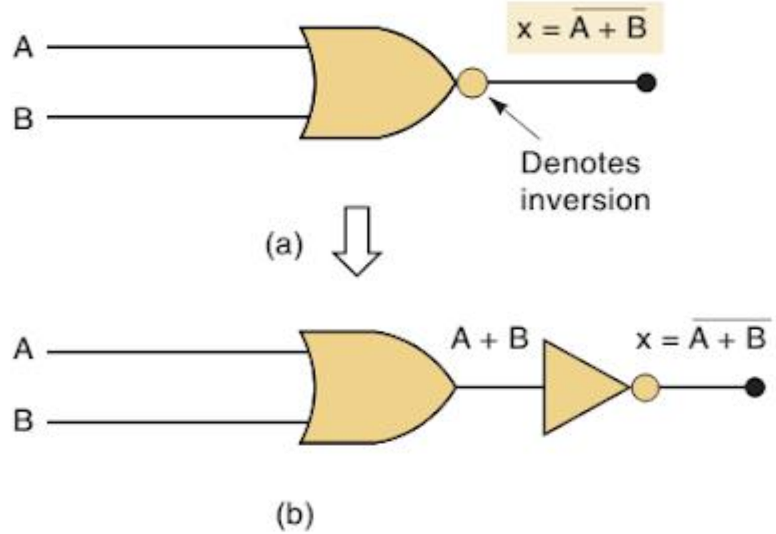


		AND	NAND
A	B	AB	$\overline{AB}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

(c)

NOR GATE

OR gate followed by NOT gate



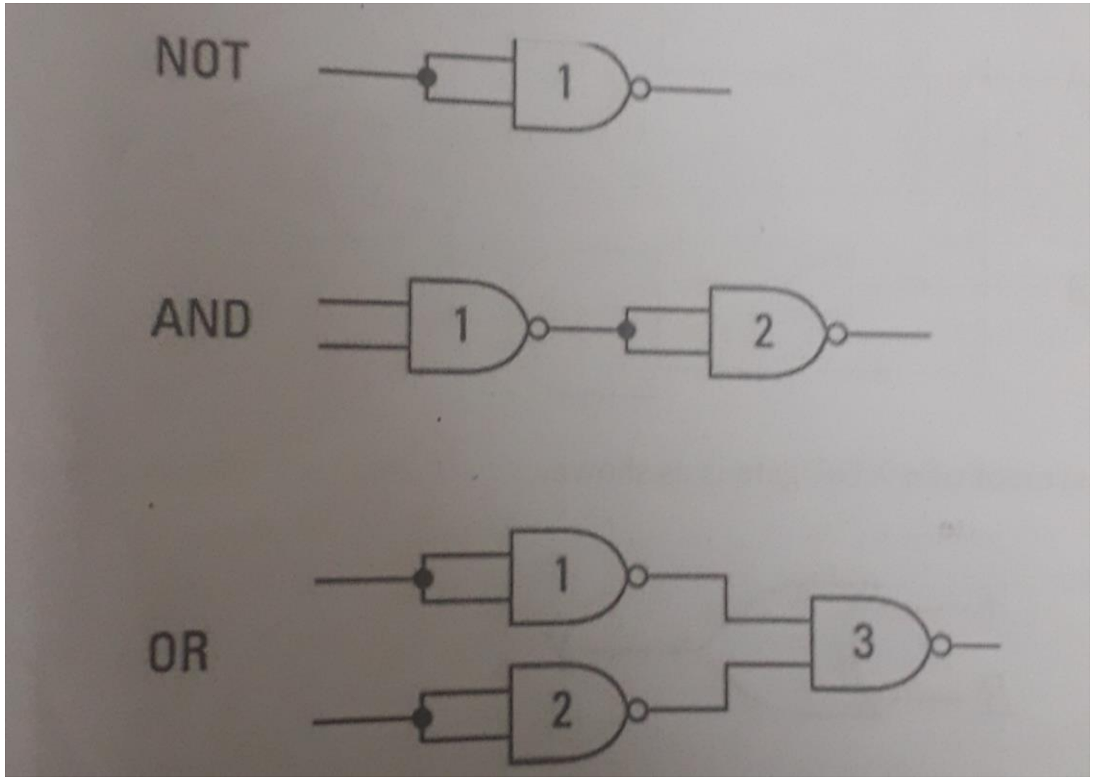
		OR	NOR
A	B	A + B	$\overline{A + B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

(c)

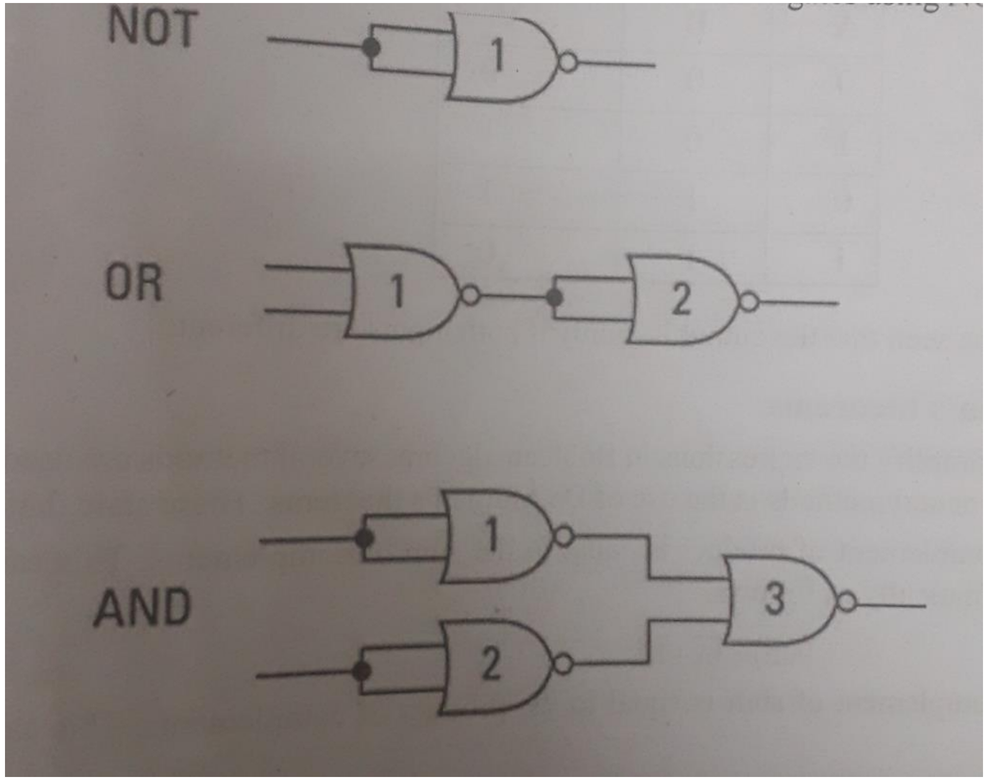
UNIVERSAL GATES

NAND and NOR gates are called universal gates since

Basic gates using NAND gate



Basic gates using NOR gate



De Morgan's Theorem -1

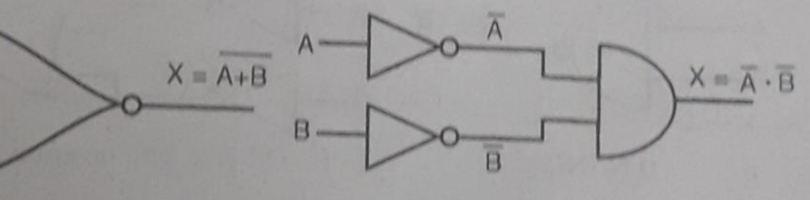
First theorem

The complement of a sum is the product of the compliments. It can be expressed as

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

This can be proved as follows.

Consider a NOR gate and an AND gate with inverted inputs as shown in figure 5.54(a) and 5.54(b).



(a) NOR gate (b) AND gate with inverted inputs

Fig. 5.54

The truth table of figure 5.54(a) and 5.54(b) are give below.

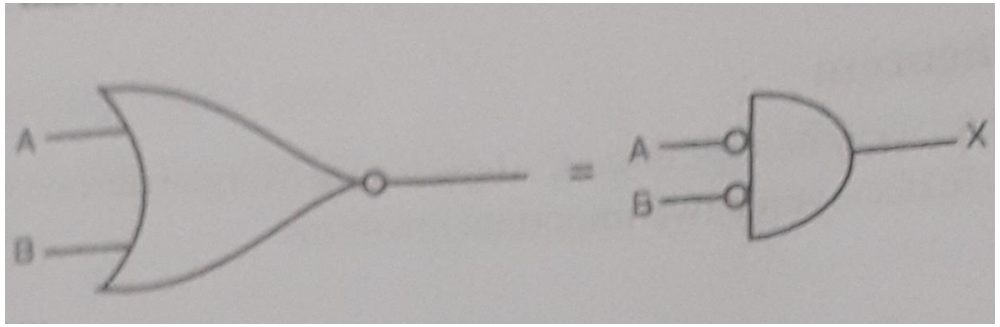
Input A	Input B	Output $X = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Truth table of NOR gate

Input A	Input B	Output $X = \overline{A}.\overline{B}$
0	0	1
0	1	0
1	0	0
1	1	0

Truth table of AND gate with inverted input

De Morgan's Theorem -2

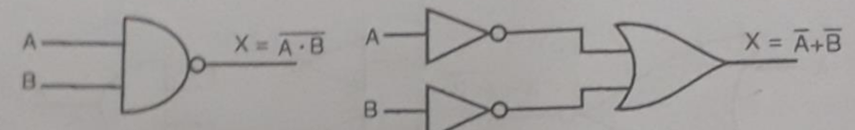


Second theorem

The complement of a product equals the sum of the complements. It can be expressed as

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

Consider a NAND gate and an OR gate with inverted inputs as shown in figure 5.55(a) and 5.55(b).



(a) NAND gate (b) OR gate with inverted inputs

Fig. 5.55

The truth table for figure 5.55(a) and 5.55(b) are given below.

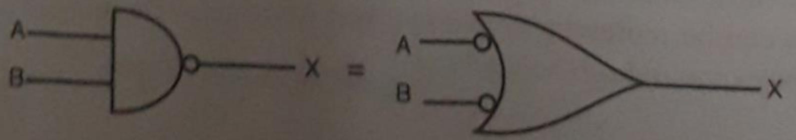
Input		Output
A	B	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Truth table of NAND gate

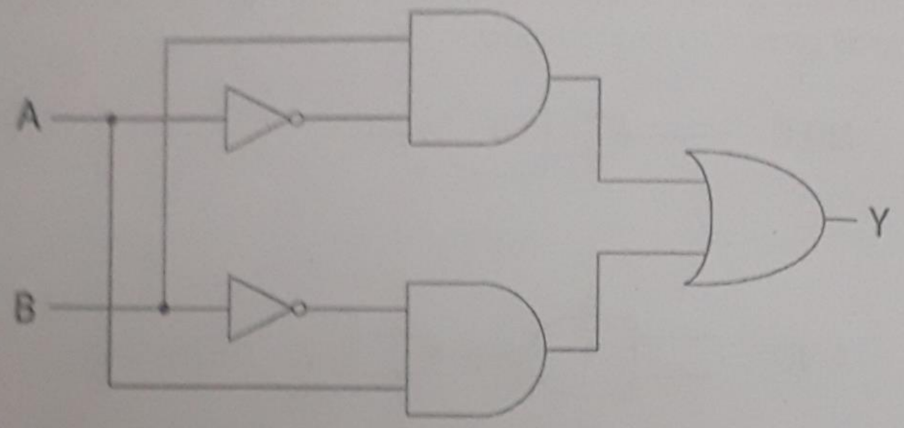
Input		Output
A	B	$X = \overline{A}+\overline{B}$
0	0	1
0	1	1
1	0	1
1	1	0

Truth table of OR gate with inverted inputs

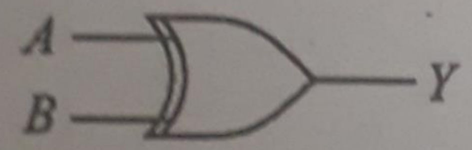
The two truth tables are identical and therefore, the two circuits are logically equivalent. OR gate with inverted inputs can be represented by a bubbled OR gate. De Morgan's second theorem therefore, can be expressed symbolically as



Exclusive OR gate(XOR gate)



The circuit symbol of a XOR gate is as shown.



The truth table of a XOR gate is as given below.

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

It can be seen that the output is 1 only if both inputs are different.