Al-Mamoon University

College of Science

Department of Medical Physics

lecture (3):

Basic Logic Gates NOT, OR, AND

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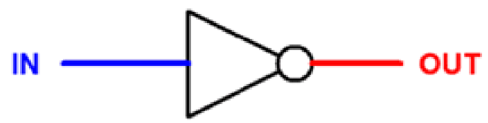
Chapter Two: Logic circuits

The gate: Is a digital circuit with one or more input voltages but only one output voltage.

Examples: The NOT gate, The OR gate and The AND gate.

Q: What is an inverter and why is it called by this name?

A: Inverter: is a gate with only one input and one output. It is called an inverter because the output state is always opposite the input state, when the input voltage is high, the output is low.



Truth Table Logic:

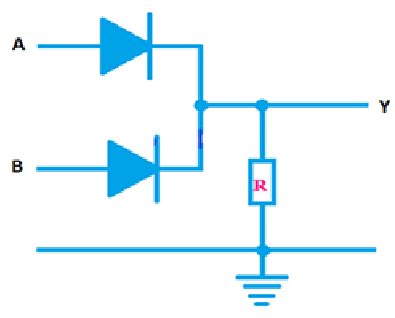
- For a 2-input table (A, B), there are 4 rows. Column A is filled with (0,0,1,1) and Column B with (0,1,0,1).
- For a 3-input table (A, B, C), there are 8 rows (2^3=8).

OR Gate

An OR gate has two or more input signals but only one output signal.

Q: Why is the OR gate called by this name?

A: It is called OR gate because the output voltages is high if any or all of the input voltages are high.



The number of rows in a truth equals 2^n

Where n: is the number of input.

For 2-input OR gate, the truth table has $2^2 = 4$ rows,

For 3-input OR gate, the truth table has $2^3 = 8$ rows,

For 4-input OR gate, the truth table has $2^4 = 16$ rows, and so on.

A logic gate truth table shows each possible input combination to the gate or circuit with the resultant output depending upon the combination of these input (s):

Two input (OR) gate truth table:

Input Combination 1. “A: Low” “B: Low” or (0, 0)

Input Combination 2. “A: Low” “B: High” or (0, 1)

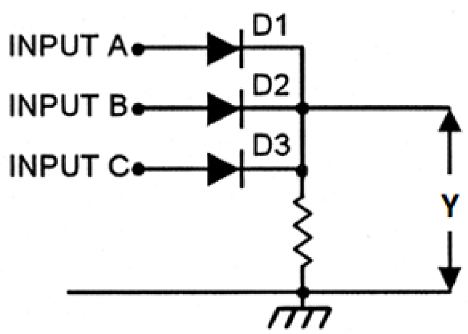
Input Combination 3. “A: High” “B: Low” or (1, 0)

Input Combination 4. “A: High” “B: High” or (1, 1)

$2^2 = 4$ rows

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

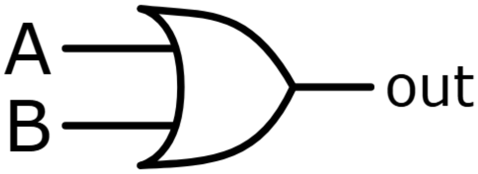
Three input (OR) gate:



$2^3 = 8$ rows

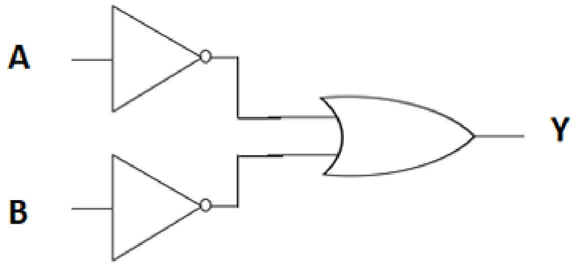
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Logic symbols:



Note: The output is high when an input is high. The only way to get a low output is by having all inputs low.

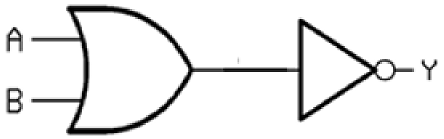
Ex: Work out the truth table for down figure:



sol:

A	B	$\bar{A}$	$\bar{B}$	Y = $\bar{A}$ OR $\bar{B}$
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

Ex: Work Out the truth table for the following circuit:

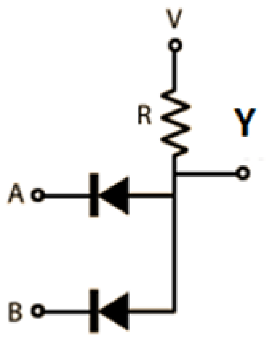


Sol:

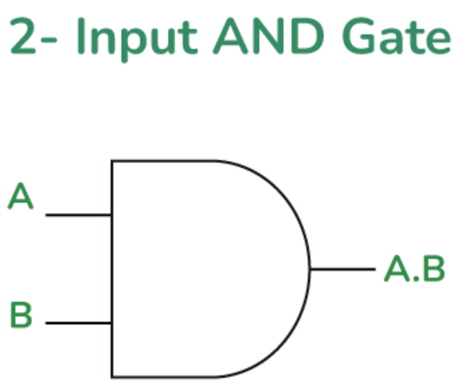
A	B	Y	$\bar{Y}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

AND Gate

The AND gate has a high output only when all inputs are high.



Logic symbols:



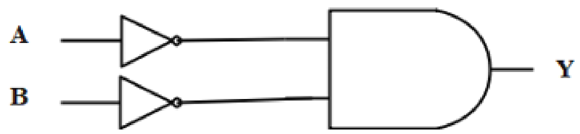
Truth Table

A (Input 1)	B (Input 2)	X = (A.B)
0	0	0
0	1	0
1	0	0
1	1	1

Three input (AND) gate truth table:

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

Ex: Work out the truth table for down circuit:



Sol:

A	B	$\bar{A}$	$\bar{B}$	Y = $\bar{A}$ OR $\bar{B}$
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

Ex: Work out the truth table for following circuit:

Sol:

A	B	Y	$\bar{Y}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Boolean Algebra

1- NOT operation:

$Y = \bar{A}$ (Read as **Y** equals **NOT A**)

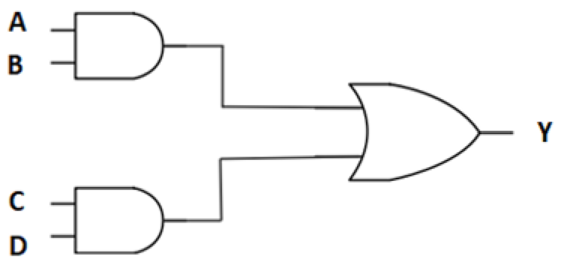
2- OR operation

$Y = A + B$

3- AND operation:

$Y = A . B$

Ex: What is the Boolean equation for the down logic circuit?



Sol:

Y1 = A . B

Y2 = C . D

Y3 = Y1 + Y2

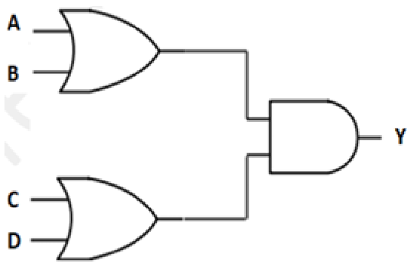
Y3 = AB + CD

Note:

1. This circuit is called AND-OR network because input AND gates derive an output OR gate.

2. An equation in this form is referred to as a sum-of-products equation. AND OR networks always produce sum-of-products equation.

Ex: What is the Boolean equation for the down logic circuit?



Sol:

Y1 = A + B

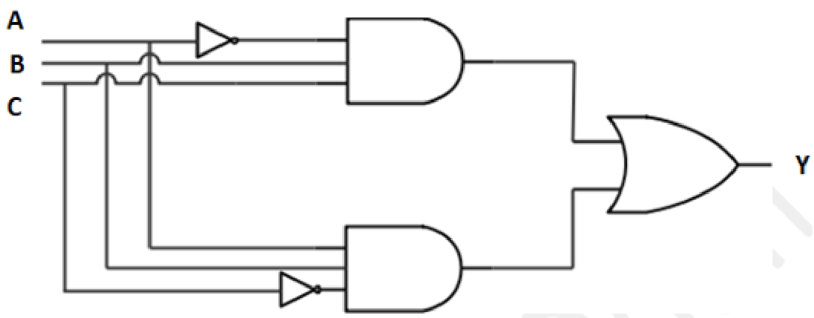
Y2 = C + D

Y3 = Y1 . Y2

Y3= (A + B) . (C + D)

Notice that the final answer is a product of sum. So, OR-AND networks always produce product-of-sum equations.

Ex: What is the Boolean equation for the down logic circuit?



Sol:

$$Y_6 = \bar{A}\ B\ C$$

$$Y_{10} = A\ B\ \bar{C}$$

$$Y_{13} = Y_6 + Y_{10}$$

$$Y_{13} = \bar{A}\ B\ C + A\ B\ \bar{C}$$

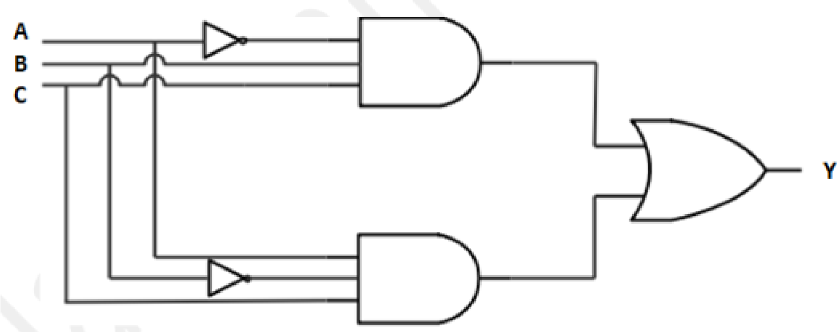
Ex: What is the logic circuit whose Boolean equation is:

$$Y = \bar{A}BC + A\bar{B}C$$

Sol:

$Y_1 = \bar{A}BC$

$Y_2 = A\bar{B}C$



Note: This example illustrates one method of logic design.