Logical Design

Lecture 9

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Basic Logic Gates

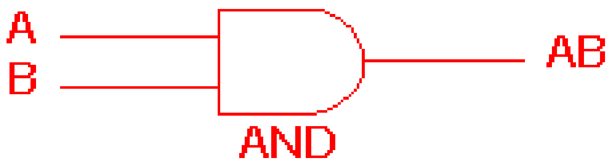
A **logic gate** is a device that acts as a building block for digital circuits. They perform basic logical functions that are fundamental to digital circuits. Most electronic devices we use today will have some form of logic gates in them. For example, logic gates can be used in technologies such as smartphones, tablets or within memory devices.

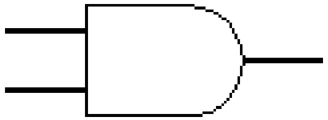
In a circuit, logic gates will make decisions based on a combination of digital signals coming from its inputs. Most logic gates have two inputs and one output. Logic gates are based on **Boolean algebra**. A logic gate can be thought of like a light switch, wherein one position the output is off -- 0, and in another, it is on -- 1. Logic gates are commonly used in integrated circuits (IC).

Basic logic gates

There are seven basic logic gates: **AND, OR, XOR, NOT, NAND, NOR**, and **XNOR**.

The **AND** gate is an electronic circuit that gives a **high** output (1) only if **all** its inputs are high.



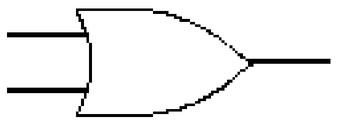


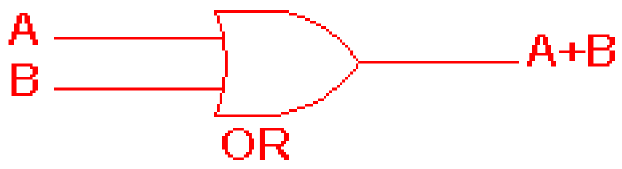
2 Input AND gate

A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1

Basic Logic Gates (**OR** gate)

The **OR** gate is an electronic circuit that gives a high output (1) if **one or more** of its inputs are high. A plus (+) is used to show the OR operation.

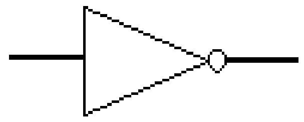


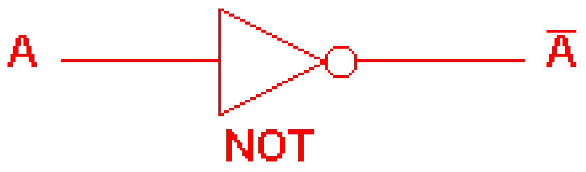


2 Input OR gate		
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

Basic Logic Gates (**NOT** gate)

The **NOT** gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an *inverter*. If the input variable is A, the inverted output is known as NOT A.

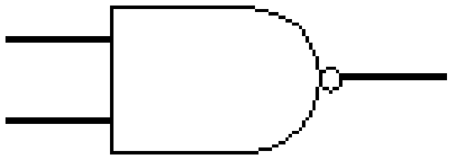


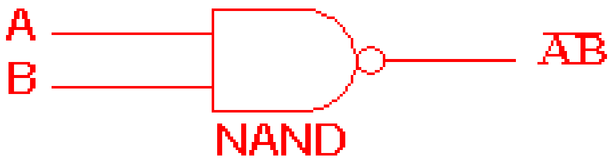


NOT gate	
A	$\bar{A}$
0	1
1	0

Basic Logic Gates (**NAND** gate)

This is a **NOT-AND** gate which is equal to an AND gate followed by a NOT gate. The outputs of all NAND gates are high if **any** of the inputs are low.

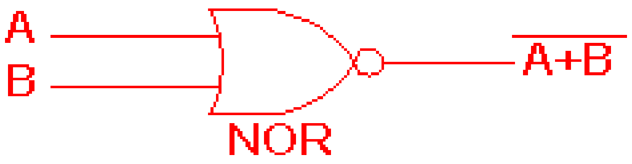




2 Input NAND gate		
A	B	$\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Basic Logic Gates (**NOR** gate)

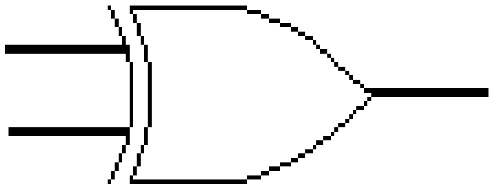
This is a **NOT-OR** gate which is equal to an OR gate followed by a NOT gate. The outputs of all NOR gates are low if **any** of the inputs are high. The symbol is an OR gate with a small circle on the output. The small circle represents inversion.

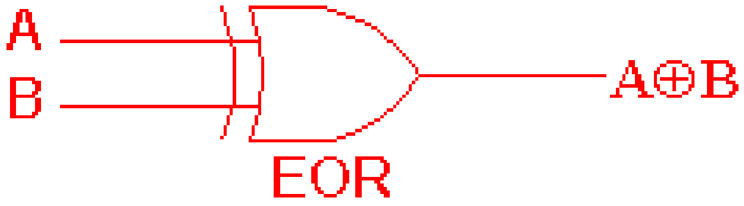


A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

Basic Logic Gates (**XOR** gate)

The '**Exclusive-OR**' gate is a circuit which will give a high output if **either, but not both**, of its two inputs are high.   An encircled plus sign ($\oplus$) is used to show the XOR operation.

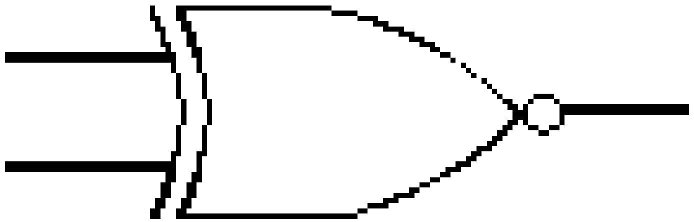




2 Input EXOR gate		
A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Basic Logic Gates (**XNOR** gate)

The *XNOR (exclusive-NOR) gate* is a combination XOR gate followed by an inverter. Its output is "true" if the inputs are the same, and "false" if the inputs are different.



2 Input EXNOR gate		
A	B	$\overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1