LECTURE 1

DIGITAL ELECTRONICS

Logic Gates, Boolean Algebra, Combinational Circuits

Logic Gates

A logic gate is an elementary building block of a digital circuit. Most logic gates have two input

and one output.

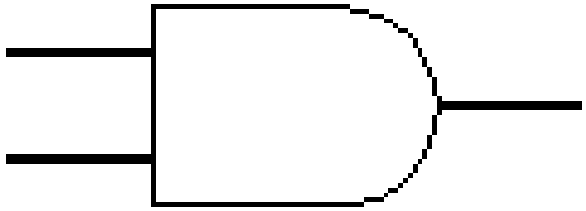
At any given moment, every terminal is in one of the two binary conditions *low* (0) or *high* (1), represented by different voltage levels.

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

0 is called "false" and 1 is called "true,”

AND Gate

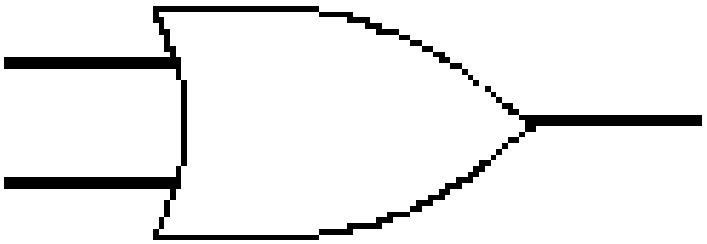
- The output is "true" when both inputs are "true." Otherwise, the output is "false."



Input 1	Input 2	Output
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate

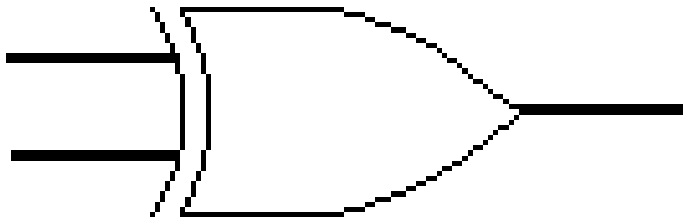
- The *OR gate* gets its name from the fact that it behaves after the fashion of the logical inclusive "or." The output is "true" if either or both of the inputs are "true." If both inputs are "false," then the output is "false.“



Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	1

XOR Gate

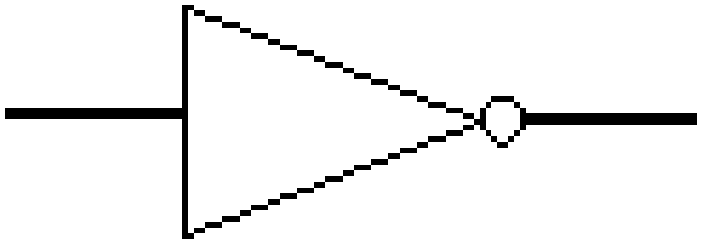
- The *XOR* (*exclusive-OR*) *gate* acts in the same way as the logical "either/or." The output is "true" if either, but not both, of the inputs are "true." The output is "false" if both inputs are "false" or if both inputs are "true."



Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

NOT Gate

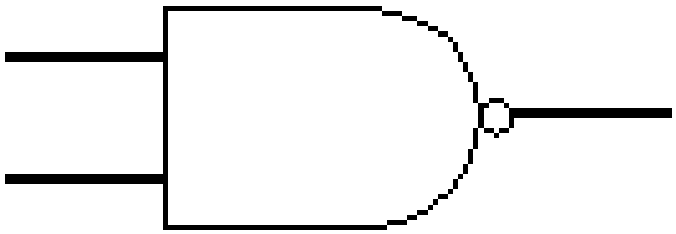
- logical *inverter* , sometimes called a *NOT gate* to differentiate it from other types of electronic inverter devices, has only one input. It reverses the logic state.



Input	Output
1	0
0	1

NAND Gate

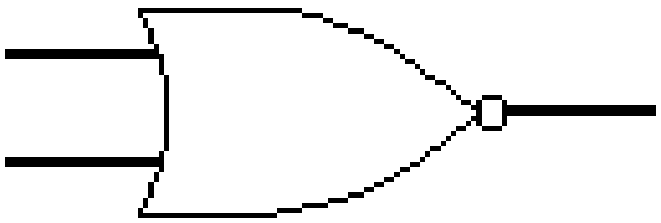
- The *NAND gate* operates as an AND gate followed by a NOT gate. It acts in the manner of the logical operation "and" followed by negation. The output is "false" if both inputs are "true." Otherwise, the output is "true."



Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate

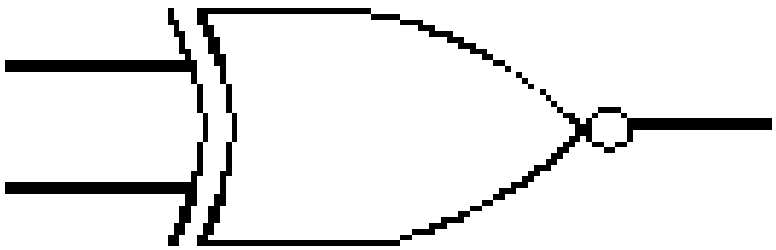
- The *NOR gate* is a combination OR gate followed by an inverter. Its output is "true" if both inputs are "false." Otherwise, the output is "false."



Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

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



Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	1

- Using combinations of logic gates, complex operations can be performed. In theory, there is no limit to the number of gates that can be arrayed together in a single device.
- But in practice, there is a limit to the number of gates that can be packed into a given physical space.
- Arrays of logic gates are found in digital integrated circuits (ICs).

- As IC technology advances, the required physical volume for each individual logic gate decreases and digital devices of the same or smaller size become capable of performing ever-more-complicated operations at ever-increasing speeds.