LOGIC GATES

Introduction

- Computers are electronic devices. The basic elements of a computer control the flow of electricity.

- Controlling the flow of electricity in a computer allows us to make decisions and perform calculations

A Gate

- A gate is a device that performs a basic operation on electrical signals.
- A gate accepts one or more input signals and produces a single output signal.
  - A low voltage signal is shown as a 0 (zero)
  - A high voltage signal is shown as a 1 (one)
- Gates are combined into circuits to perform tasks such as arithmetic and store values.

Notation when describing Gates

- Boolean Expressions

  - is an expression that results in a boolean value, that is, in a value of either true or false.

- Logic diagrams
  - This is a graphical version of a circuit
- Truth tables
  - Defines the function of a gate by listing all the possible input combinations along with the corresponding output

6 Types of Gates

- NOT
- AND
- OR
- XOR
- NAND
- NOR

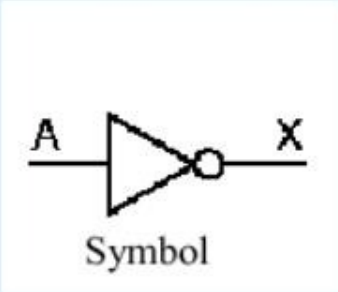
NOT Gate

- A NOT gate accepts *one* input signal and produces *one* output signal.

Boolean Expression

$X = A'$

Logic Diagram Symbol



Truth Table

A	X
0	1
1	0

A NOT gate is sometimes referred to as an **inverter** because it inverts (reverses) the input value

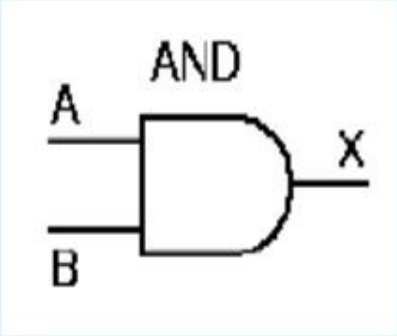
AND Gate

- An AND gate accepts *two* input signals and produces *one* output signal.

Boolean Expression

$$X = A \cdot B$$

Logic Diagram Symbol



Truth Table

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

The values of both input signals determine what the output signal will be.

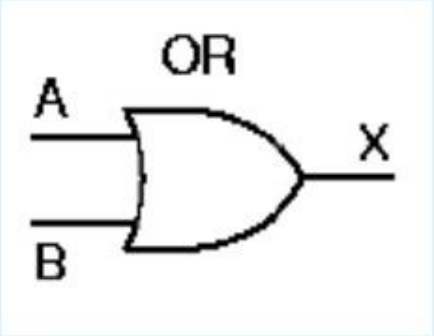
OR Gate

- An OR gate accepts *two* input signals and produces *one* output signal.

Boolean Expression

$$X = A + B$$

Logic Diagram Symbol



Truth Table

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

The values of *either* signals determine what the output signal will be.

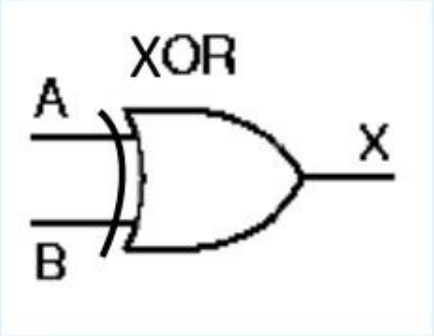
XOR Gate

- An XOR (exclusive OR) gate accepts *two* input signals and produces *one* output signal.

Boolean Expression

$X = A \oplus B$

Logic Diagram Symbol



Truth Table

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

An XOR gate produces a 0 if its two inputs are the same and an 1 when inputs are mixed, ie 0 and 1.

OR versus XOR Gate

- The only difference between an OR gate and an XOR gate is when both input signals are 1.

Truth Table (OR)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table (XOR)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

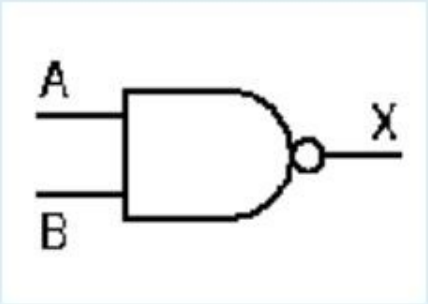
NAND Gate

- A NAND (Not AND) gate is the opposite of the AND gate.

Boolean Expression

$$X = (A \cdot B)'$$

Logic Diagram Symbol



Truth Table

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

The output of NAND gate is equal to the output of an AND gate which is put through a NOT gate.

The output of NAND gate is equal to the output of an AND gate which is put through a NOT gate.

AND Gate

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

NOT Gate inverts signal

X
1
1
1
0

NAND Gate

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

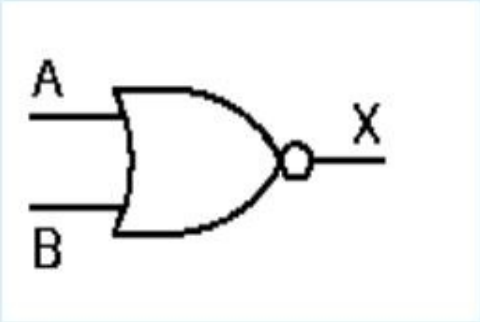
NOR Gate

- A NOR (Not OR) gate is the opposite of the OR gate.

Boolean Expression

$X = (A + B)'$

Logic Diagram Symbol



Truth Table

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

The output of NOR gate is equal to the output of an OR gate which is put through a NOT gate.

The output of NOR gate is equal to the output of an OR gate which is put through a NOT gate.

OR Gate

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

NOT Gate inverts signal

X
1
0
0
0

NOR Gate

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

Overview of Gates

- A NOT gate inverts its single input value.
- An AND gate produces 1 if both values are 1
- An OR gate produces 1 if either input is 1 or both inputs are 1.
- An XOR gate produces 1 if either input (but not both) inputs are 1
- A NAND gate produces the opposite results of an AND gate
- A NOR gate produces the opposite results of an OR gate.

Logic gate simulator

- http://logic.ly/demo/
- http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/logicrev2.shtml