Number System

- Decimal to binary
- Binary to Decimal
- Binary to octal
- Binary to hexadecimal
- Hexadecimal to binary
- Octal to binary

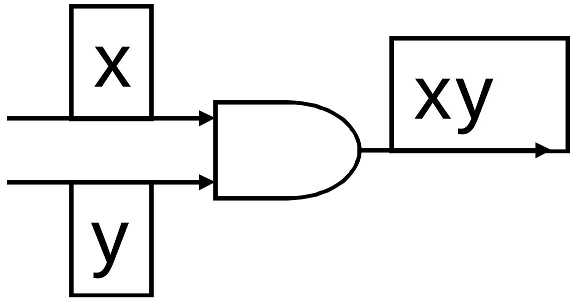
BOOLEAN ALGEBRA

BOOLEAN LOGIC OPERATIONS

- Logical AND
- Logical OR
- Logical COMPLEMENTATION (NOT)

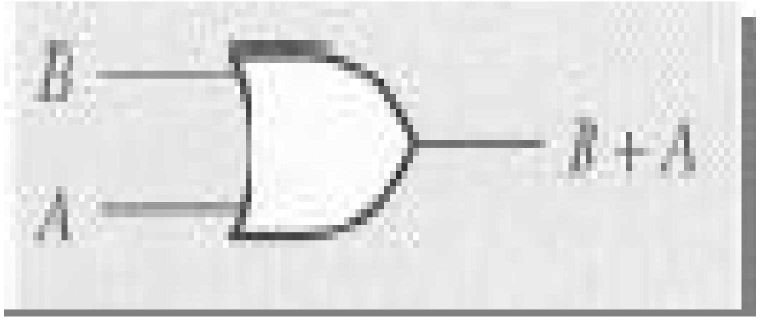
Logical AND

A	B	Y = A.B
0	0	0
0	1	0
1	0	0
1	1	1



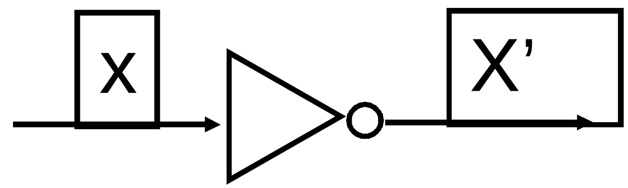
Logical OR

A	B	Y = A+B
0	0	0
0	1	1
1	0	1
1	1	1



Logical COMPLEMENTATION (NOT)

A	Y
0	1
1	0

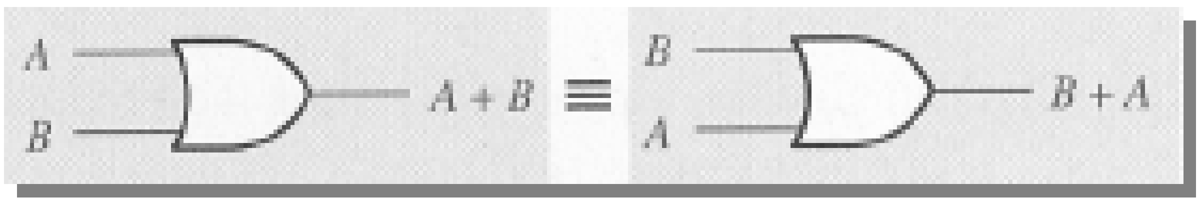


Laws of Boolean Algebra

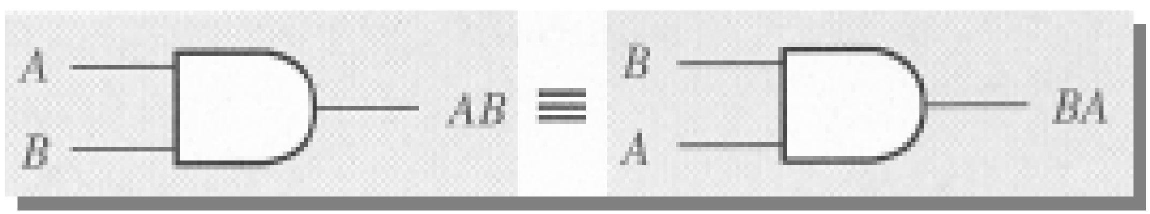
- Commutative Laws
- Associative Laws
- Distributive Law

Commutative Laws of Boolean Algebra

$$A + B = B + A$$

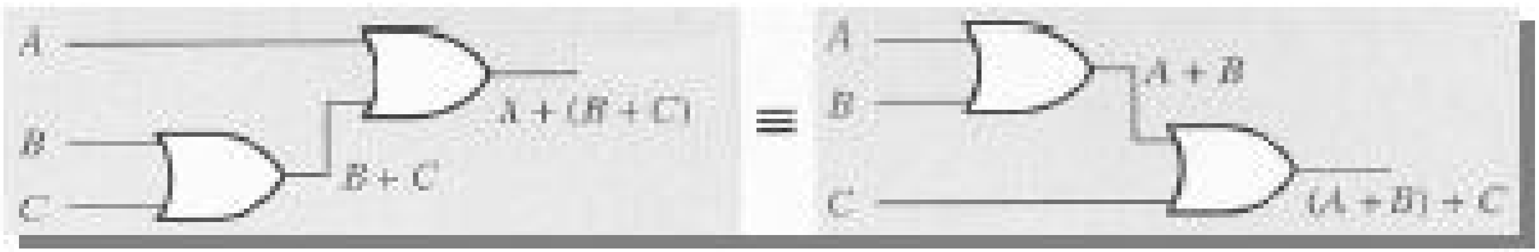


$$A \bullet B = B \bullet A$$

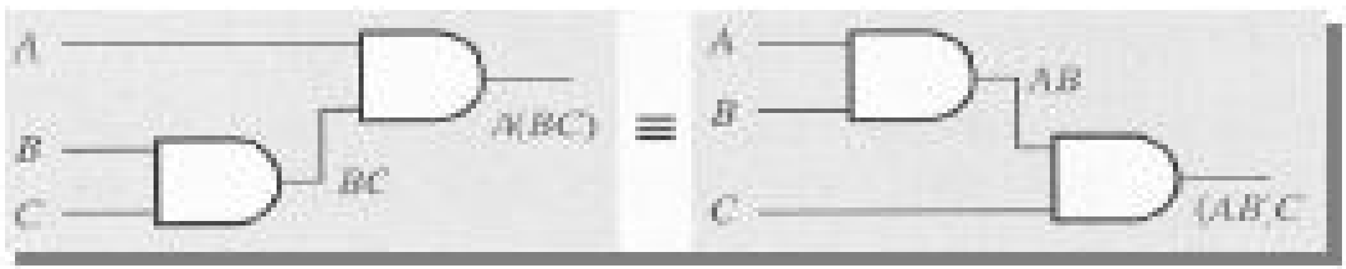


Associative Laws of Boolean Algeb

$$A + (B + C) = (A + B) + C$$



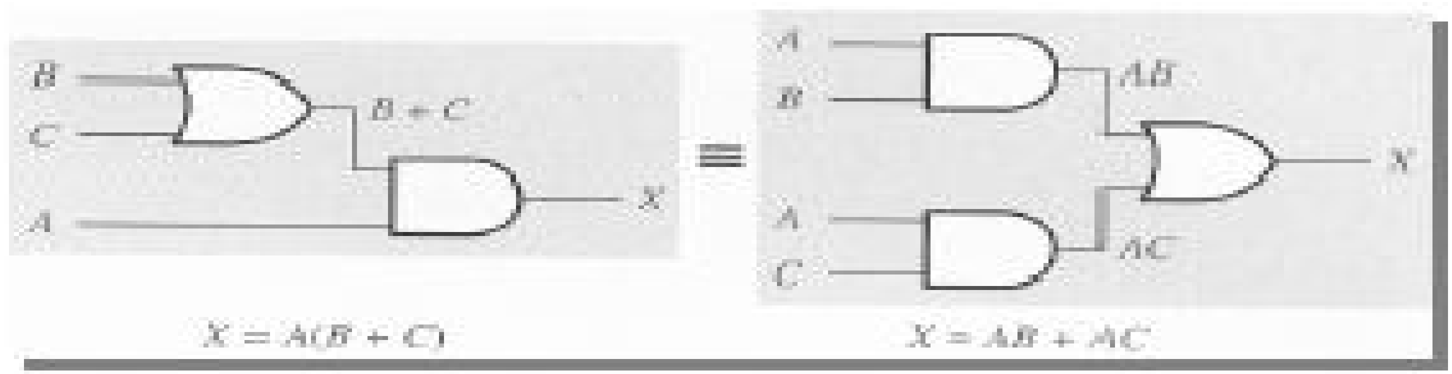
$$A \bullet (B \bullet C) = (A \bullet B) \bullet C$$



Distributive Laws of Boolean Algebra

$$A \bullet (B + C) = A \bullet B + A \bullet C$$

$$A (B + C) = A B + A C$$



Rules of Boolean Algebra

1. $A + 0 = A$
2. $A + 1 = 1$
3. $A \cdot 0 = 0$
4. $A \cdot 1 = A$
5. $A + A = A$
6. $A + \overline{A} = 1$
7. $A \cdot A = A$
8. $A \cdot \overline{A} = 0$
9. $\overline{\overline{A}} = A$
10. $A + AB = A$
11. $A + \overline{A}B = A + B$
12. $(A + B)(A + C) = A + BC$

DeMorgan's Theorems

- Theorem 1

$$\overline{(x+y)} = \overline{x} \cdot \overline{y}$$

- Theorem 2

$$\overline{(x \cdot y)} = \overline{x} + \overline{y}$$

SUM OF PRODUCTS

- The logical sum of two or more logical product terms is called sum of products. It is basically an OR operation of AND operated variables such as:

$Y = AB + BC + AC$

$Y = AB + A'C + BC$

PRODUCTS OF SUM

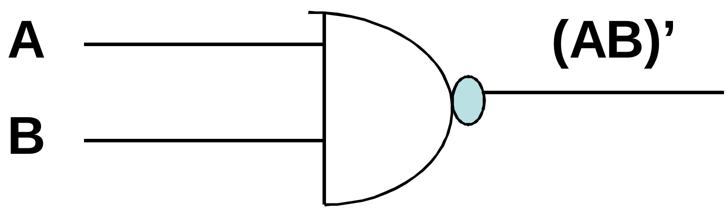
- A Product of sum expression is a logical product of two or more logical sum terms. It is basically and AND operation of OR operated variables such as:

- $Y = (A+B)(B+C)(C+A')$

Karnaugh Maps

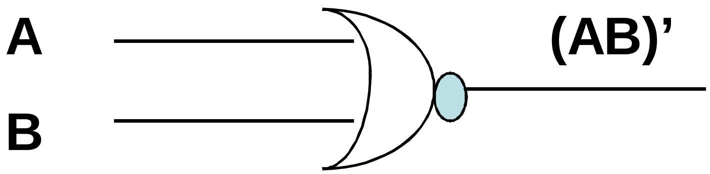
Examples

NAND GATE



A	B	Y = (A.B)’
0	0	1
0	1	1
1	0	1
1	1	0

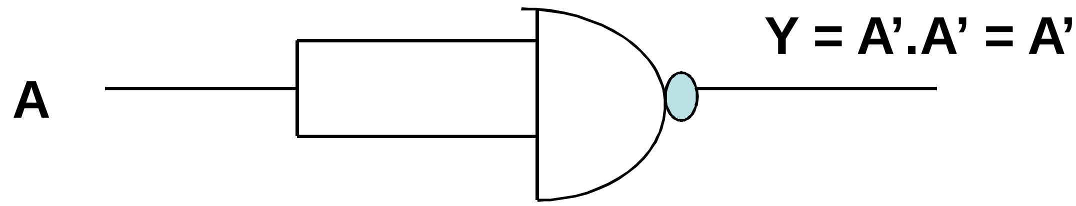
NOR GATE



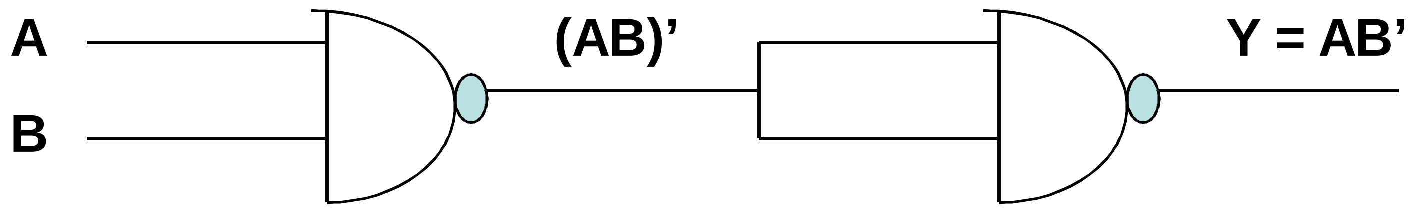
A	B	Y = (A+B)’
0	0	1
0	1	0
1	0	0
1	1	0

Universal Gates

- NAND and NOR gates are called universal gates because both can be used to implement any gate like AND,OR and NOT gate or any combination of these basic gates.

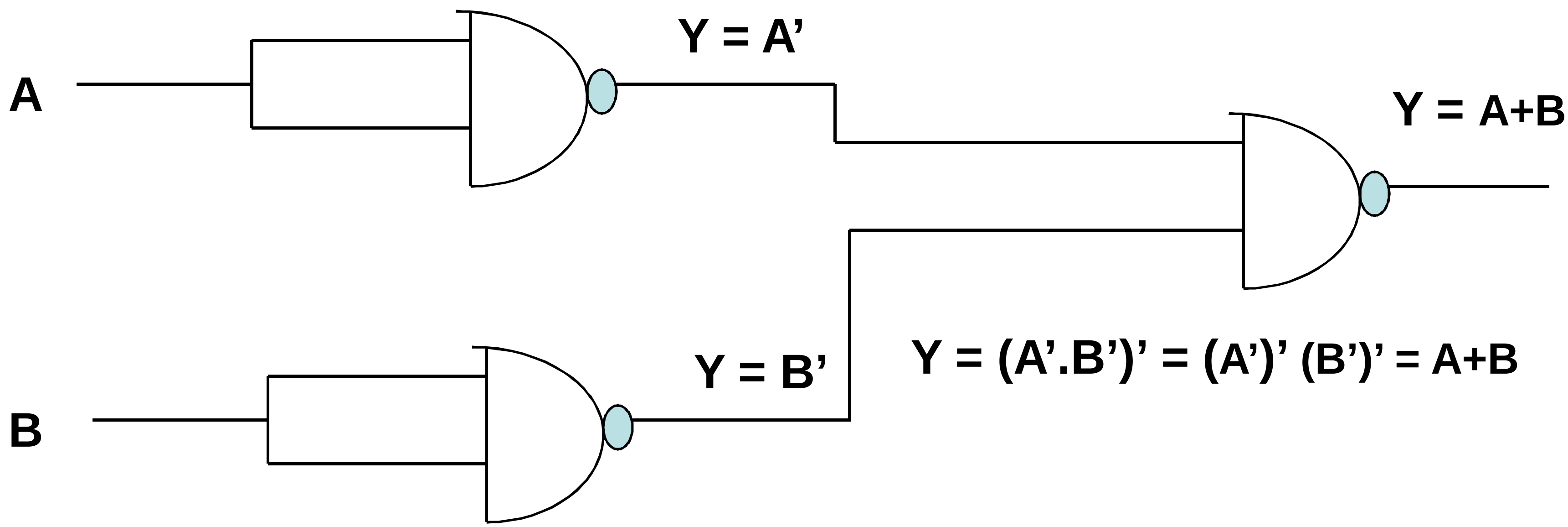


REALISATION OF NOT GATE

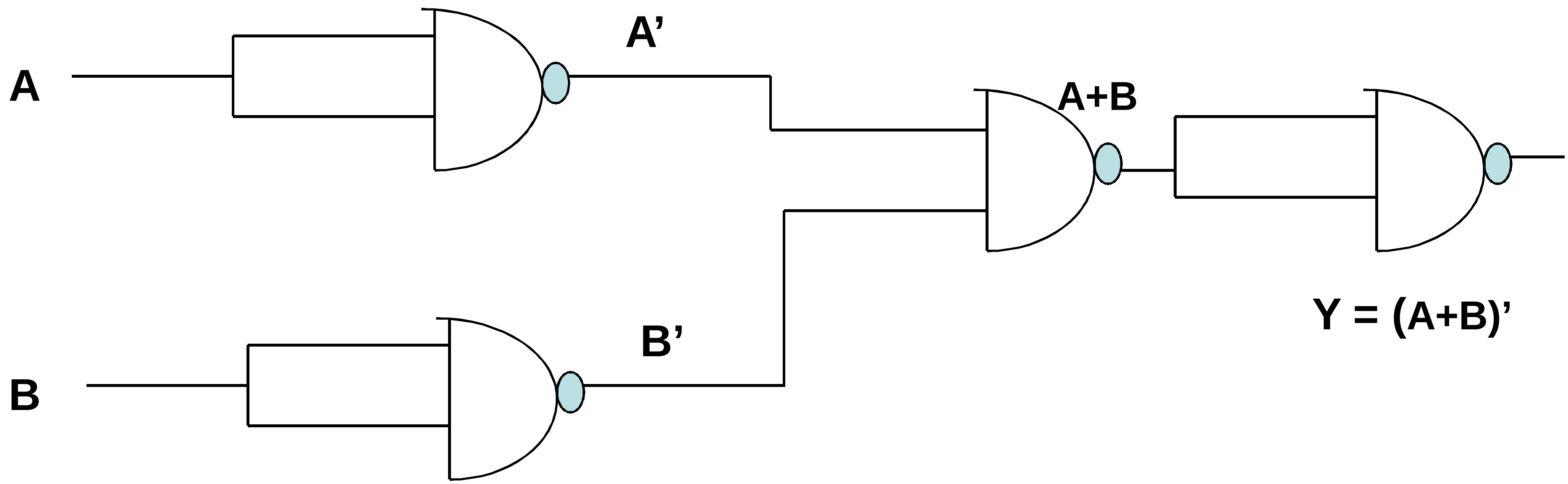


REALISATION OF AND GATE

REALISATION OF OR GATE

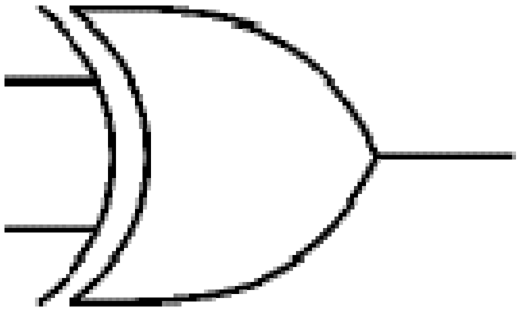


REALISATION OF NOR GATE

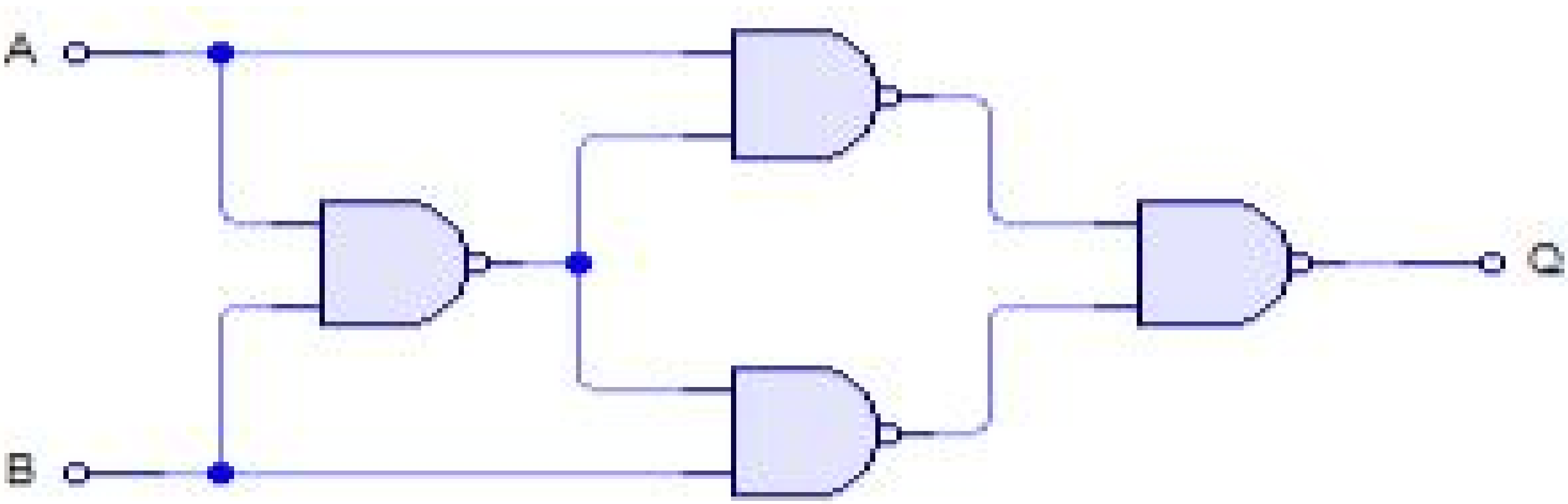


REALISE NOT, OR, AND, NAND GATES USING NOR GATES

EXCLUSIVE OR GATE

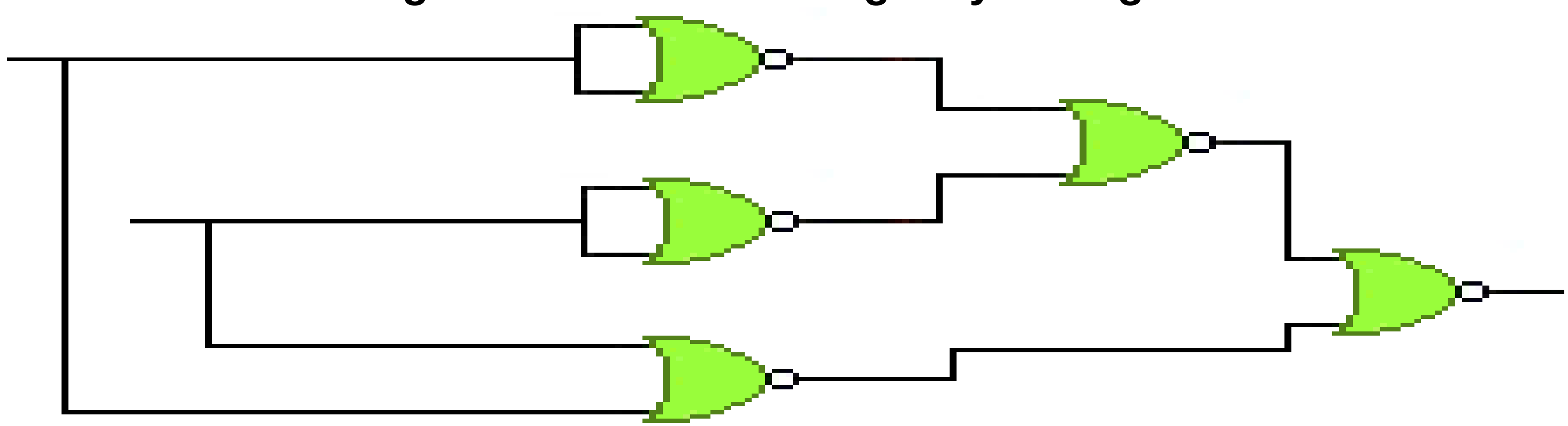


Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	0

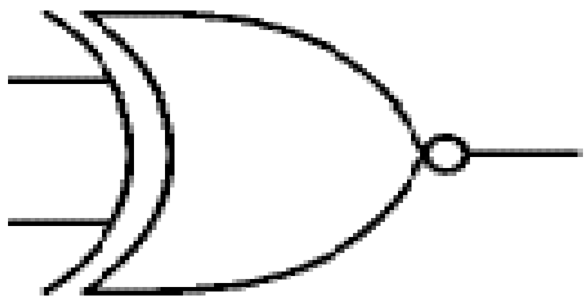


XOR gate constructed using only NAND gates

XOR gate constructed using only NOR gates



EX-NOR (EXclusive-NOR) gate



Input A	Input B	Output Q
0	0	1
0	1	0
1	0	0
1	1	1

Digital System consists of two types of circuits

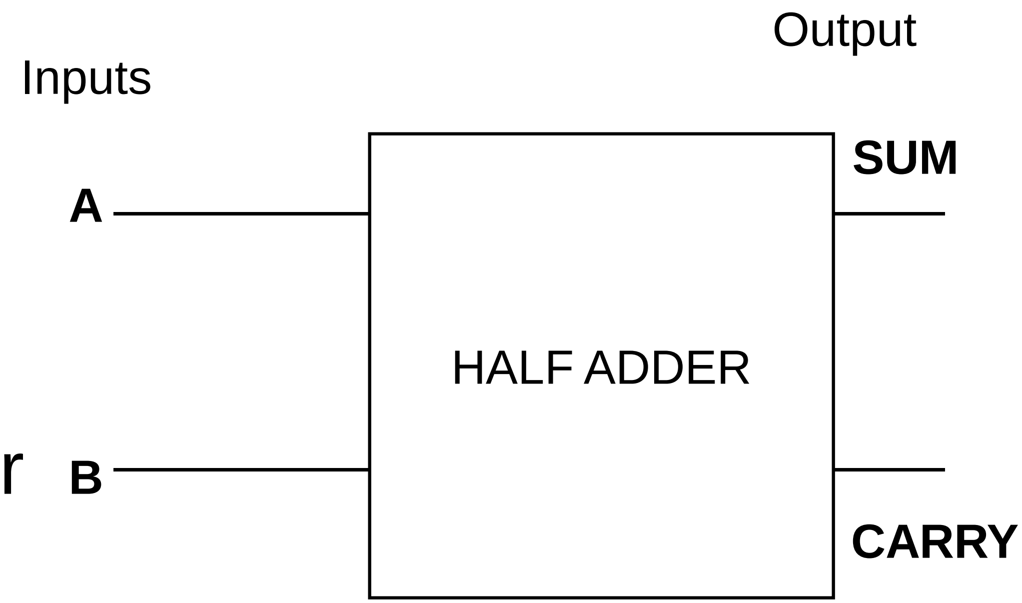
1. Combinational Logic Circuit
2. Sequential Logic Circuit

- In Combinational circuit, the output at any time depends on the input values at that time

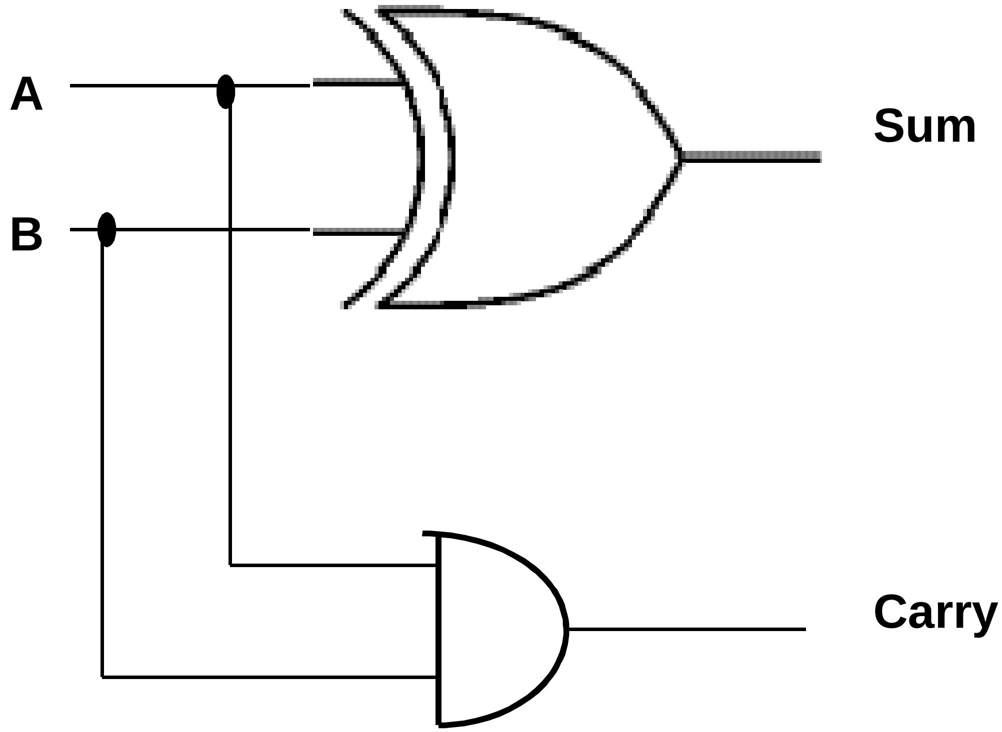
- In a Sequential circuit, the output at any time depends on the present input values as well as the past output values

Half Adder

- A half-adder is a circuit that accepts two binary inputs, *A* and *B*, and computes their sum, S, and their carry-out C_o.



Logic symbol

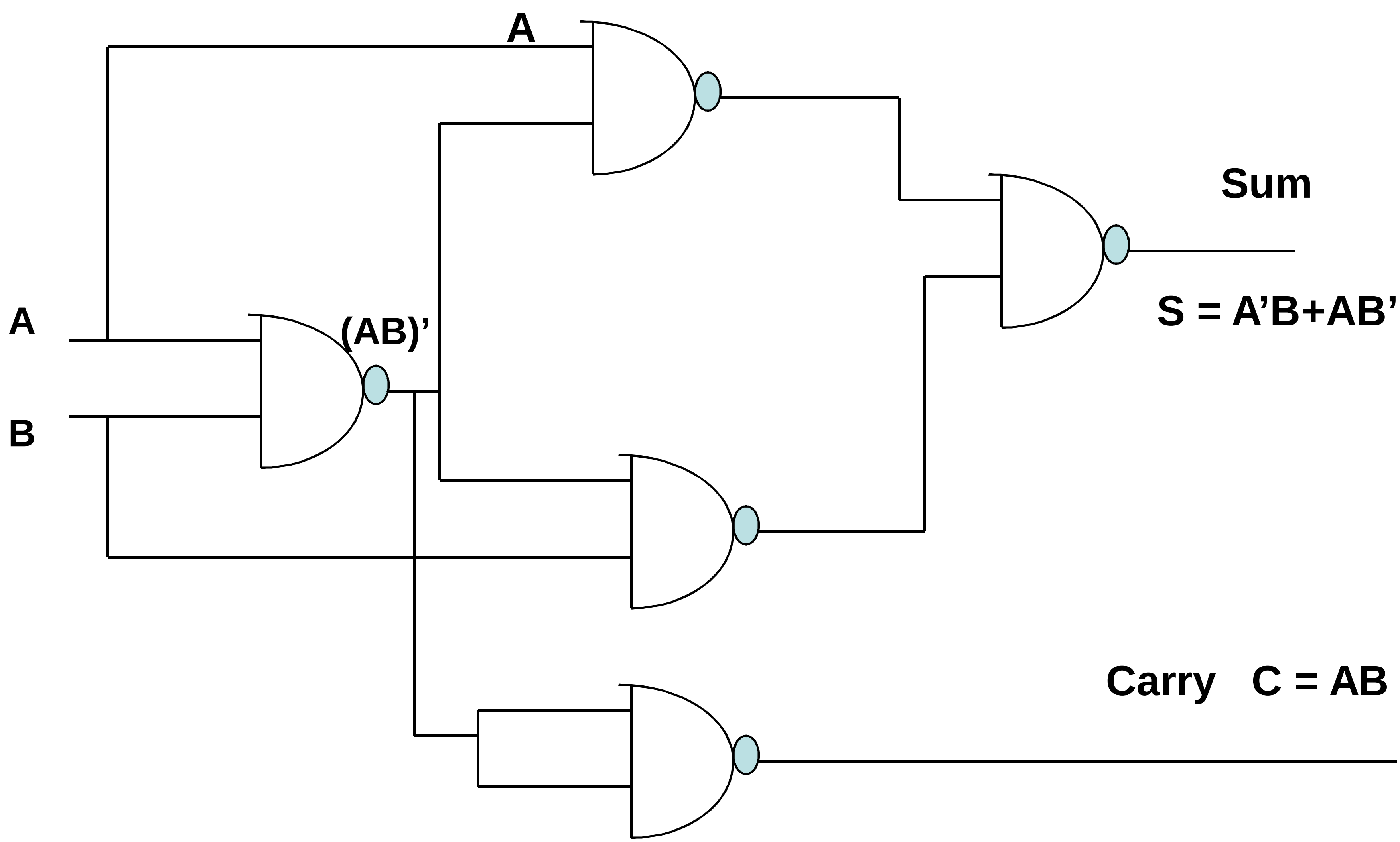


Logic Diagram

Truth Table of half adder

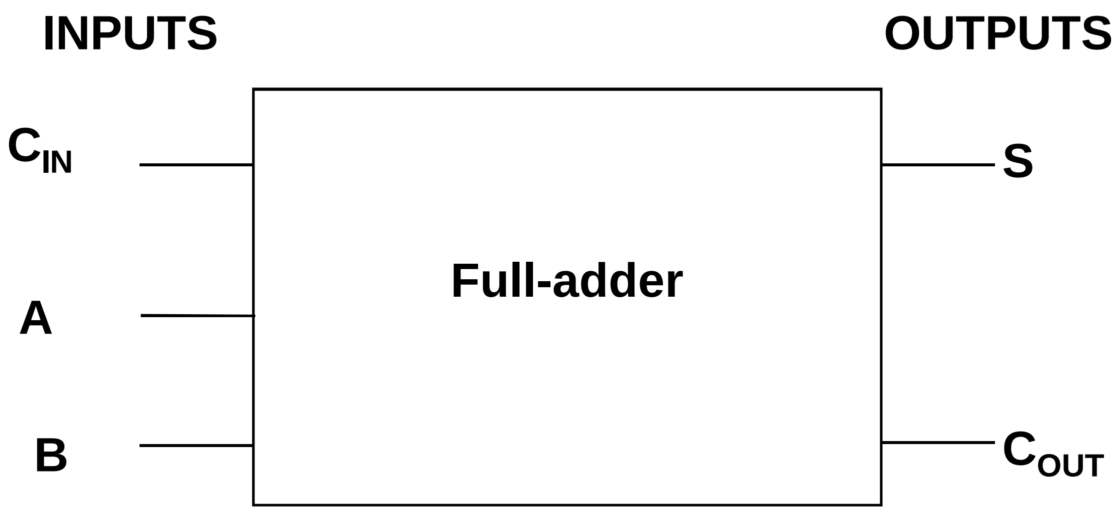
Inputs		Outputs	
A	B	SUM S	CARRY C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Using NAND GATES



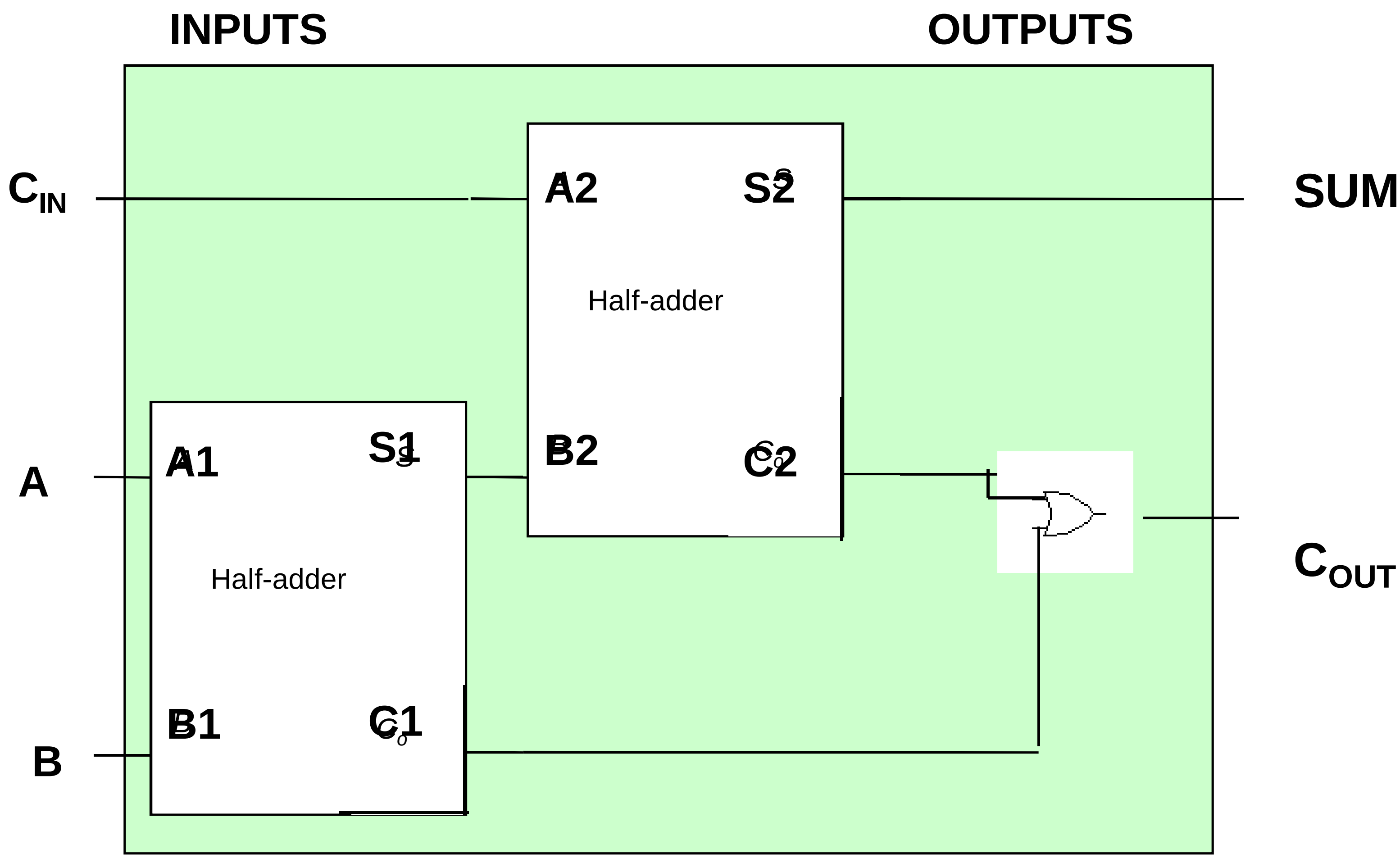
FULL ADDER

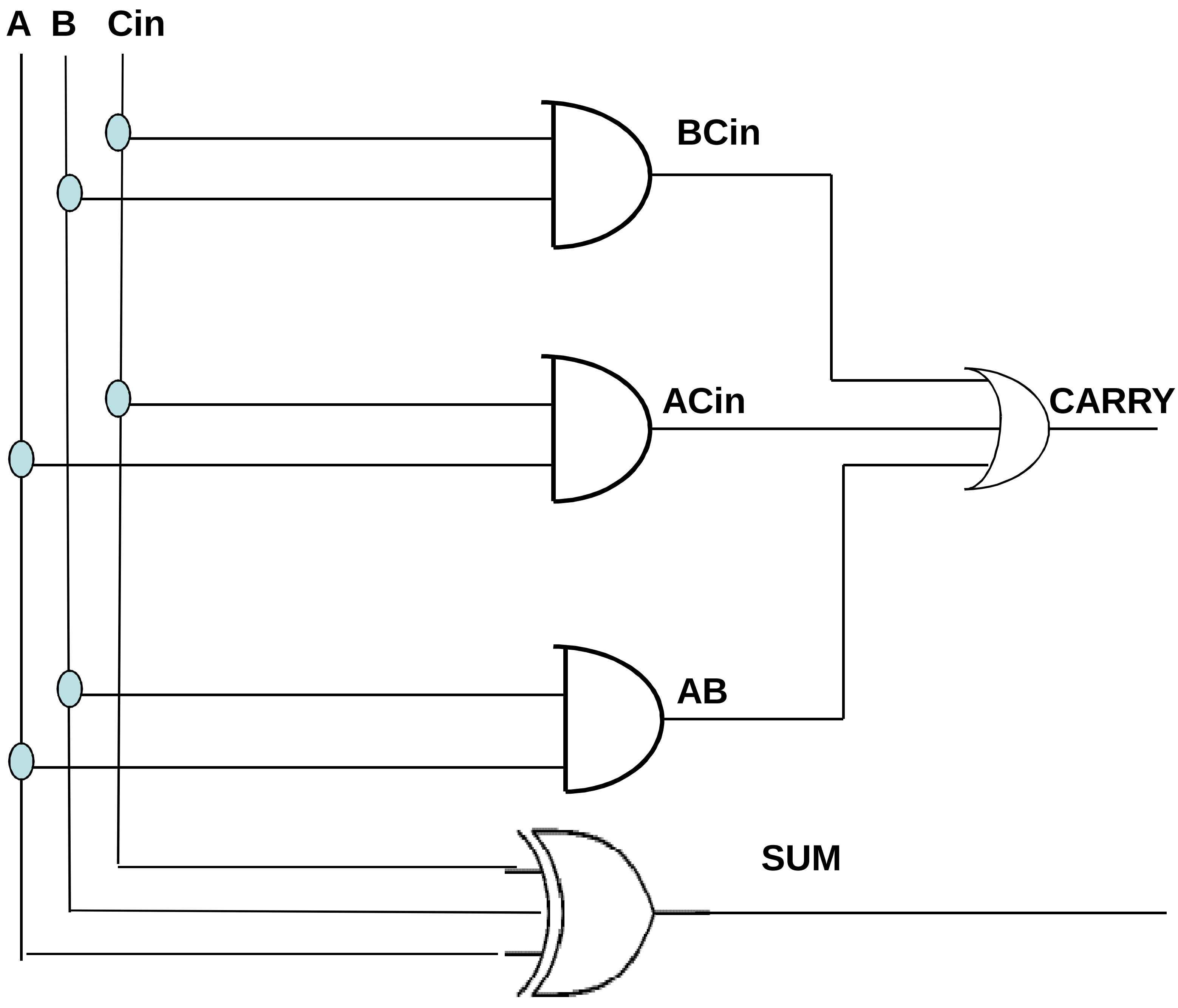
- A **full adder** is a circuit that adds two binary inputs plus a carry-in and produces the binary sum and a carry-out.



Logic Symbol

Symbol using two half adder





LOGIC DIAGRAM

Inputs			Outputs	
A	B	Cin	SUM S	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Truth Table

Combinational Circuits

- Combinational logic circuits are circuits in which the output at any time depends upon the combination of the input signals present at that instant only, and does not depends upon any past conditions

Multiplexers (Data Selectors)

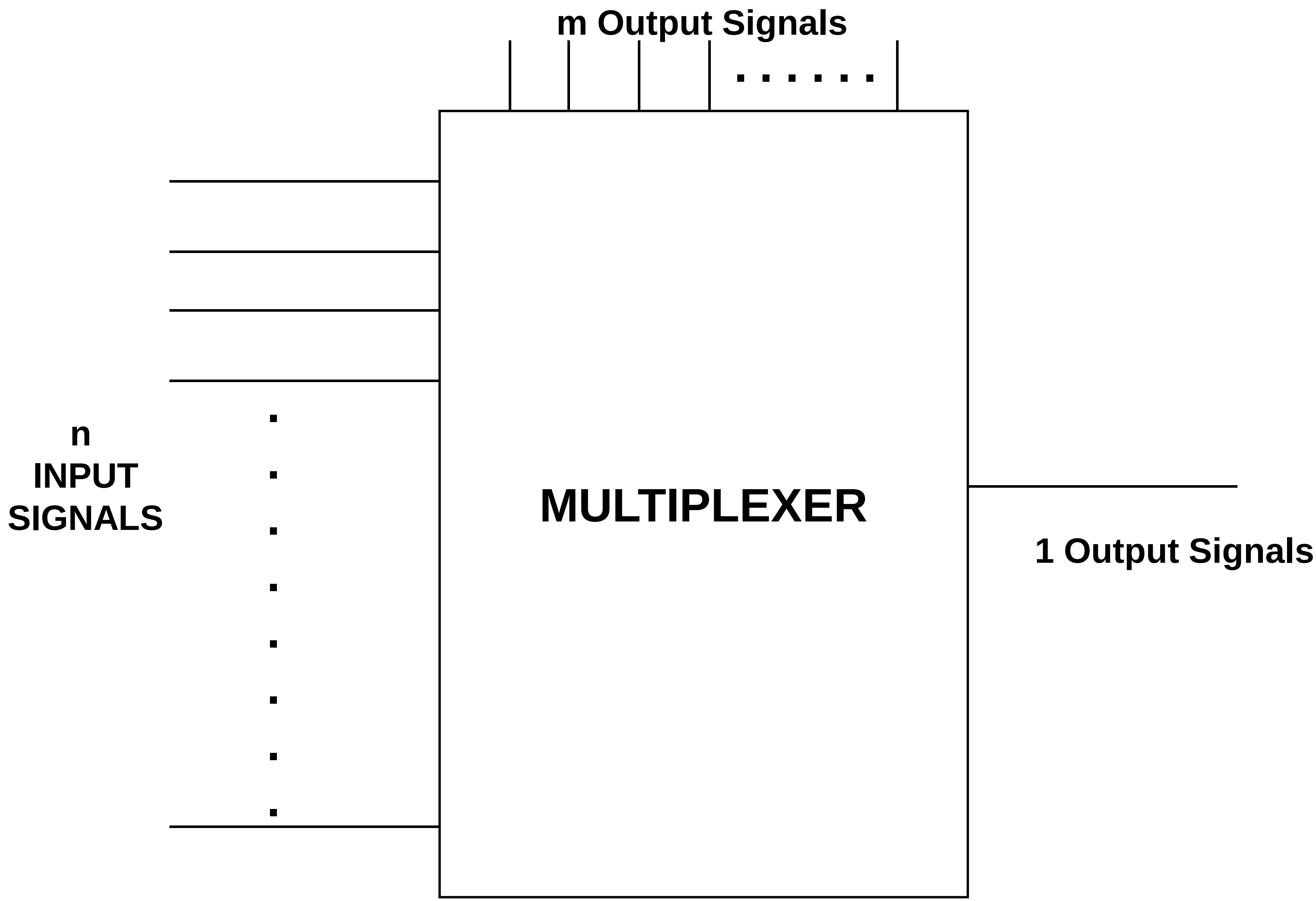
- The term ‘multiplex’ means ‘many to one’.

- Multiplexing is the process of transmitting a large number of information over a single line.

- A digital multiplexer is a combinational circuit that select one digital information from several sources and transmits the selected information on a single output line.

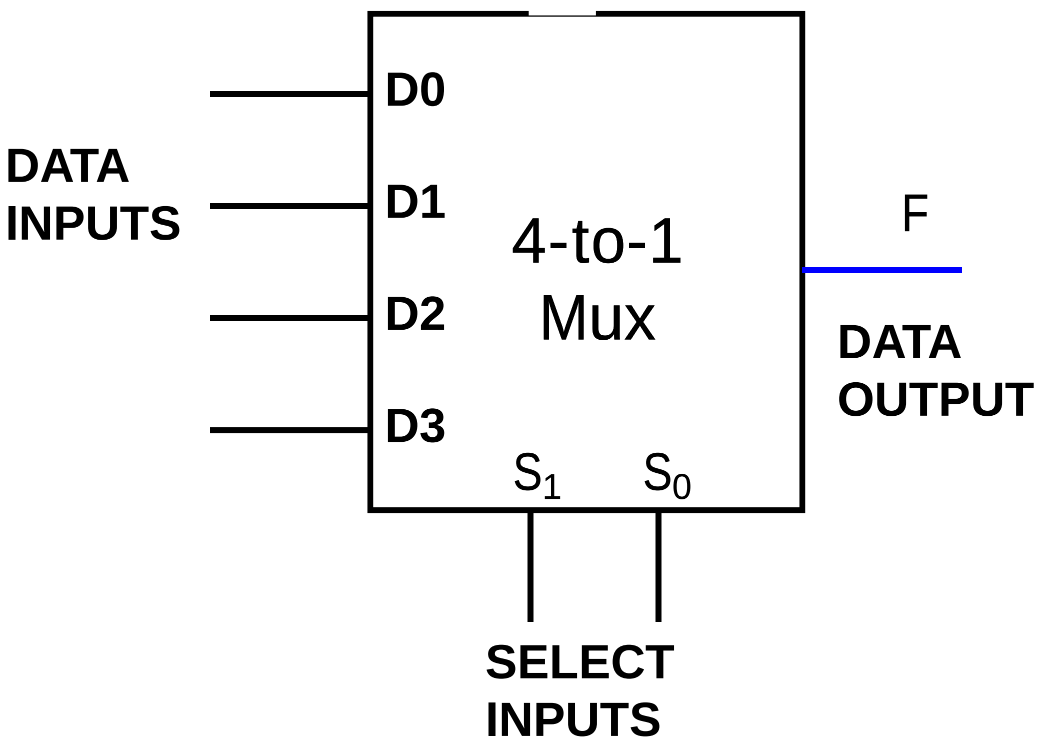
- Multiplexer is also called a ***data selector*** since it selects one to many inputs and steers the information to the output.

- Multiplexer has several data-input lines and a single output line.
- Selection of a particular input line is controlled by a set of selection lines.
- Number of n input lines is equal to $2^{m,}$ then m select lines are required to select one of the n input lines.
-
- For ex: to select 1 out of 4 input lines, two select lines are required; to select 1 to 8 input lines, three select lines are required.



BLOCK DIAGRAM OF MULTIPLEXER

BASIC FOUR-INPUT MULTIPLEXER

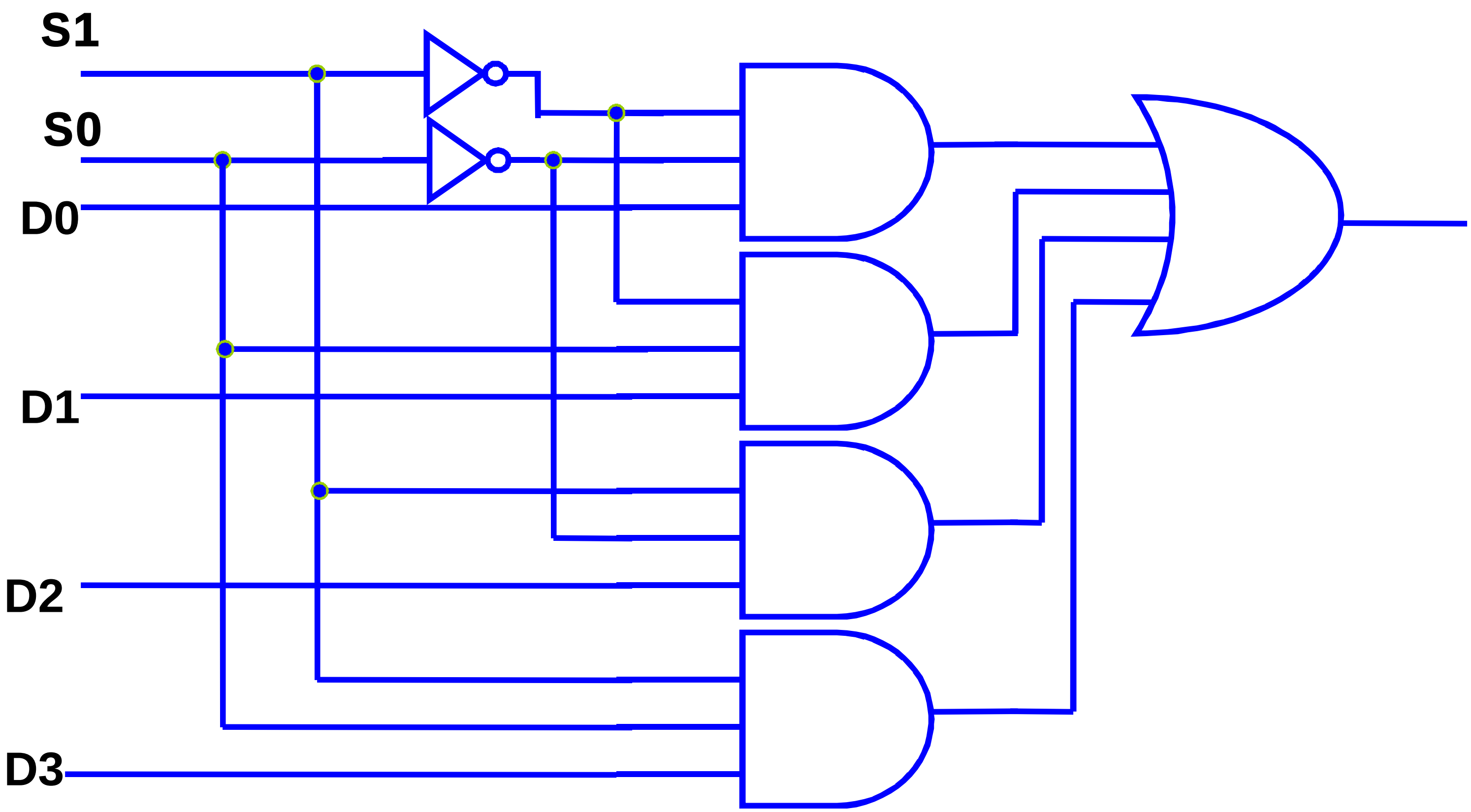


Logic Symbol

Data Select Inputs		Output
S1	S0	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

Truth Table of 4 to 1 multiplexer

Logic Diagram



- The logic symbol of a 4 to 1 multiplexer has four data input lines (**D_0 - D_3**) and a select output line (Y) and two select lines (S0 and S1) to select four input lines.

- The data output Y = D0, if and only if S1= 0 and S0 = 0

- **Y = D_0 S1' S0' ------** S1= 0 and S0 = 0
- **Y = D1 S1' S0------** S1= 0 and S0 = 1

Data Select Inputs		**Output**
S1	S0	Y
0	0	**D_0**
0	1	**D_1**
1	0	**D_2**
1	1	**D_3**

8 to 1 Multiplexer

16 to 1 Multiplexer

Decoder

- Computer is a digital system which requires decoding of the data.

- A decoder is a logic circuit which converts an n-bit binary input code into 2^n output lines, such that each output line will be activated for only one of the possible combination of inputs

The truth table of 3-to-8 Decoder

A2	A1	A0	D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	1							
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

3-to-8 Decoder