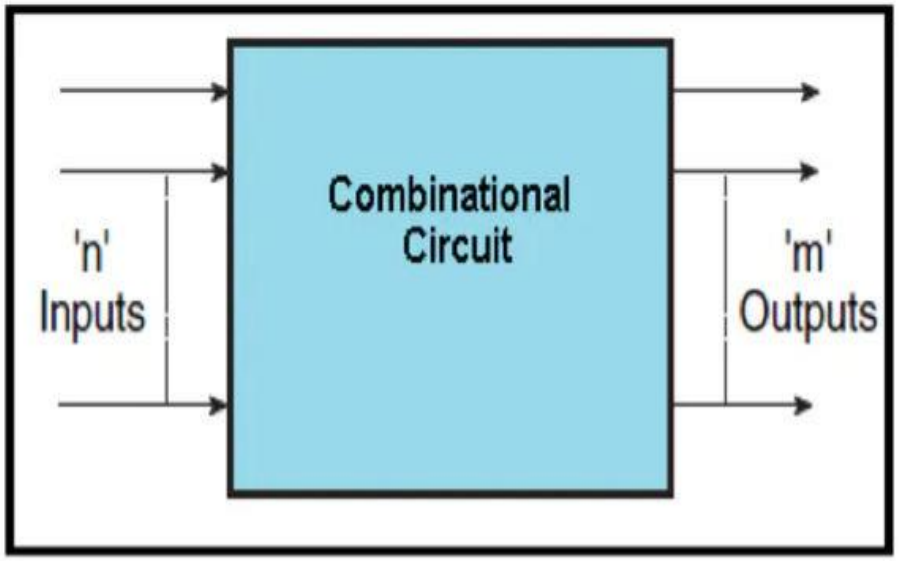
Combinational Circuits

- When logic gates are connected together to produce a specified out put on certain specified combinations of input variables, with no memory involved, then the resulting circuit is called a combinational circuit.

- Output depends only on present input. O/p = f(i/p), combinational circuit performs an operation that can be specified logically by a set of Boolean function.

- A combinational circuit may have n-binary inputs and m-binary outputs.



Adder

1. An **adder** is a digital combinational circuit that performs addition of numbers. Are used in the arithmetic logic units or ALU.

2. They are also utilized in other parts of the processor, where they are used to calculate addresses, table indices, increment and decrement operators, and similar operations.

3. Although adders can be constructed for many number representations, such as binary-coded decimal or excess-3, the most common adders operate on binary numbers.

4. In cases where two's complement or ones' complement is being used to represent negative numbers, it is trivial to modify an adder into an adder–subtractor.

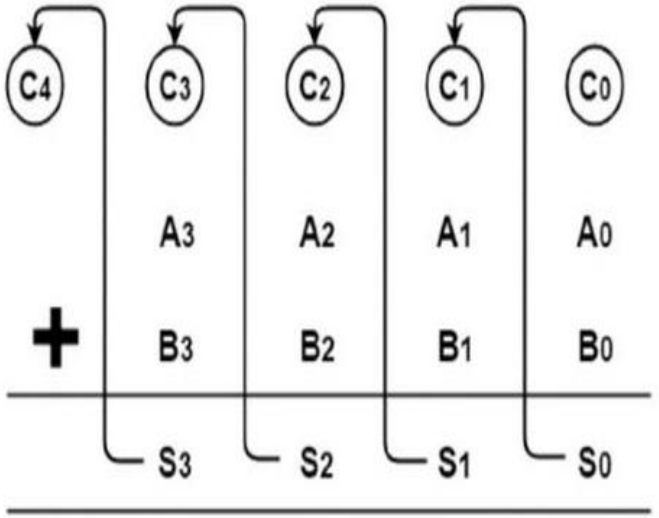
Why we need a half adder

- A binary adder-subtractor is a combinational circuit that performs the arithmetic operations of addition and subtraction with binary numbers.

- We will develop this circuit by means of a hierarchical design. The half adder design is carried out first, from which we develop the full adder.

- Connecting n full adders in cascade produces a binary adder for two n-bit numbers.

- **Basics of addition: -** $(A)_x + (B)_x = ?$



Half adder

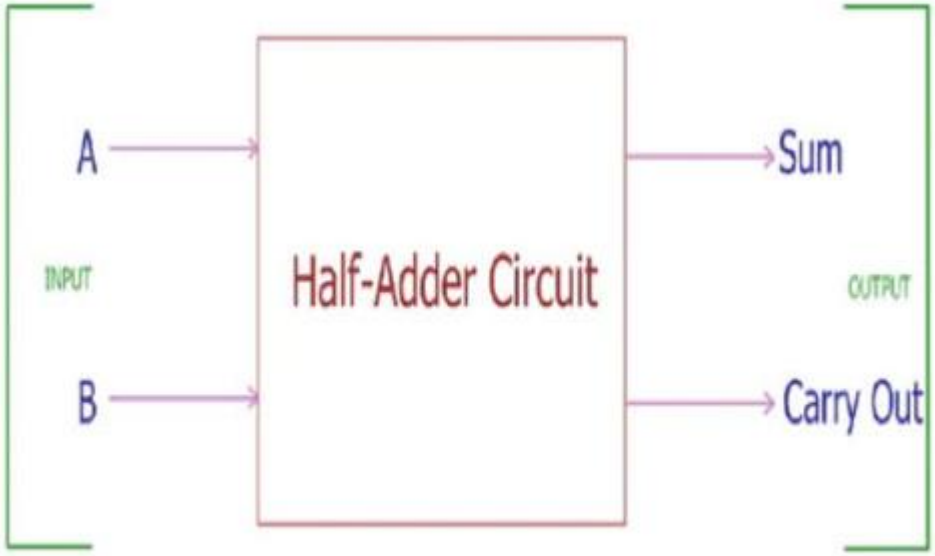
The simplest form of addition is addition of two binary digits, consists of four possible elementary operations

0+0 = 0
0+1 = 1
1+0 = 1
1+1 = 10

The first three operations produce a sum of two digits, but when both augend and addend bits are equal to 1, the binary sum consists of two digits. The higher significant bit of this result is called a carry.

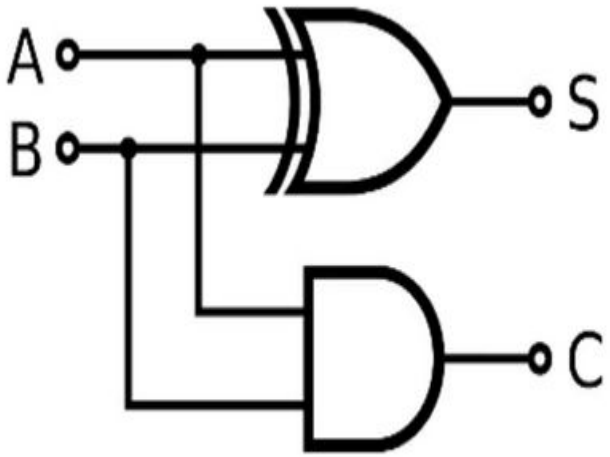
It is a combinational circuit, which perform the arithmetic addition of two one-bit binary numbers is referred to as an half-adder.

So, in half adder inputs are adds two single binary bits *A* and *B*, and two outputs, sum (*S*) and carry (C).



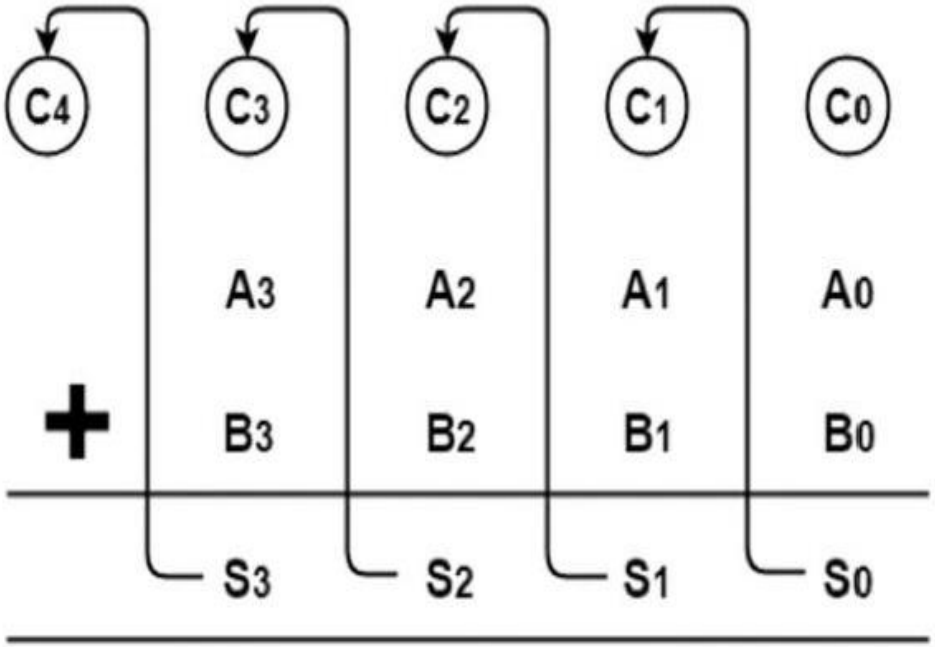
Truth table for Half adder

INPUTS		OUTPUTS	
A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1



Cost of implementation a half adder is one EX-OR gate and one AND gate.

A half adder has only two inputs and there is no provision to add a carry coming from the lower order bits when multi bit number addition is performed. For this reason, we have designed a full adder.



$A(A_3\ A_2\ A_1\ A_0)$

$B(B_3\ B_2\ B_1\ B_0)$