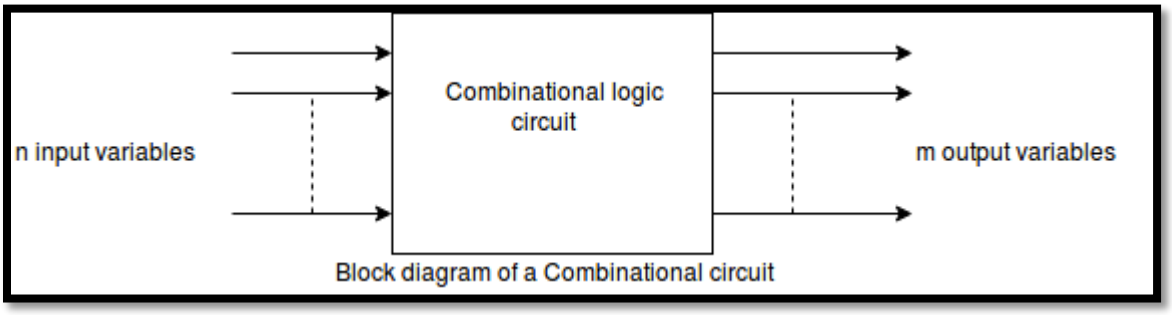
Combinational Circuits 4th sem (Computer Architecture)

A combinational circuit comprises of logic gates whose outputs at any time are determined directly from the present combination of inputs without any regard to previous inputs.

A combinational circuit performs a specific information-processing operation fully specified logically by a set of Boolean functions.

The basic components of a combinational circuit are: input variables, logic gates, and output variables.



Block diagram of a Combinational circuit

The 'n' input variables come from an external source whereas the 'm' output variables go to an external destination. In many applications, the source or destination are storage registers.

Design procedure of a Combinational Circuit

- The design procedure of a combinational circuit involves the following steps:
- The problem is stated.
- The total number of available input variables and required output variables is determined.
- The input and output variables are allocated with letter symbols.
- The exact truth table that defines the required relationships between inputs and outputs is derived.
- The simplified Boolean function is obtained from each output.
- The logic diagram is drawn.

The combinational circuit that performs the addition of two bits is called a half adder and the one that performs the addition of three bits (two significant bits and a previous carry) is a full adder.

COMPUTER SCIENCE DEPARTMENT
SANDIP ROY

Combinational Circuits 4th sem (Computer Architecture)

Half - Adder

A Half-adder circuit needs two binary inputs and two binary outputs. The input variable shows the augend and addend bits whereas the output variable produces the sum and carry. We can understand the function of a half-adder by formulating a truth table. The truth table for a half-adder is:

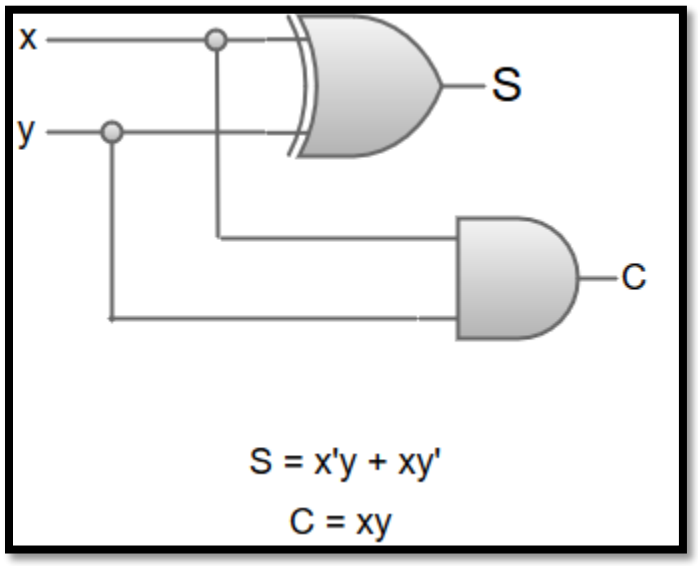
x	y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

- 'x' and 'y' are the two inputs, and S (Sum) and C (Carry) are the two outputs.
- The Carry output is '0' unless both the inputs are 1.
- 'S' represents the least significant bit of the sum.

The simplified sum of products (SOP) expressions is:

S = x'y+xy', C = xy

The logic diagram for a half-adder circuit can be represented as:



Combinational Circuits 4th sem (Computer Architecture)

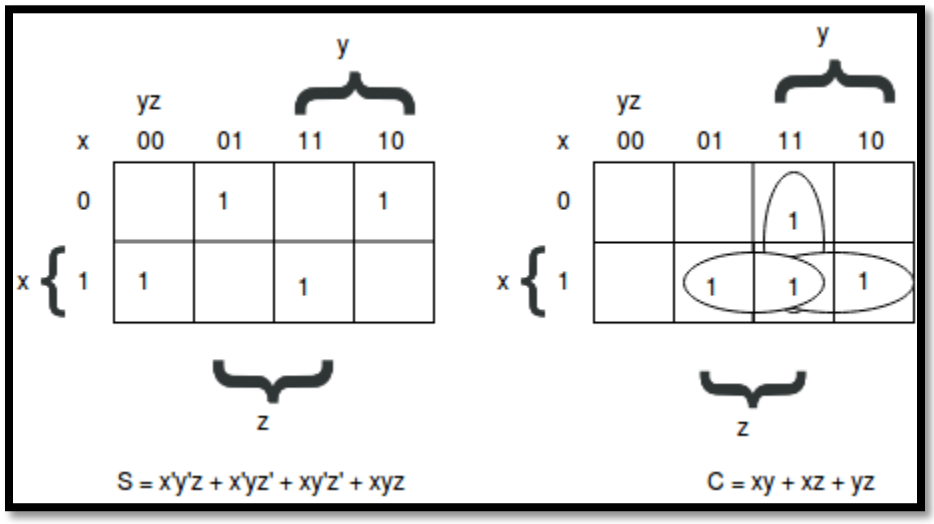
Full - Adder

This circuit needs three binary inputs and two binary outputs. The truth table for a full-adder is:

x	y	z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

- Two of the input variable 'x' and 'y', represent the two significant bits to be added.
- The third input variable 'z', represents the carry from the previous lower significant position.
- The outputs are designated by the symbol 'S' for sum and 'C' for carry.
- The eight rows under the input variables designate all possible combinations of 0's, and 1's that these variables may have.
- The input-output logical relationship of the full-adder circuit may be expressed in two Boolean functions, one for each output variable.
- Each output Boolean function can be simplified by using a unique map method.

Maps for a full-adder:



The logic diagram for a full-adder circuit can be represented as: