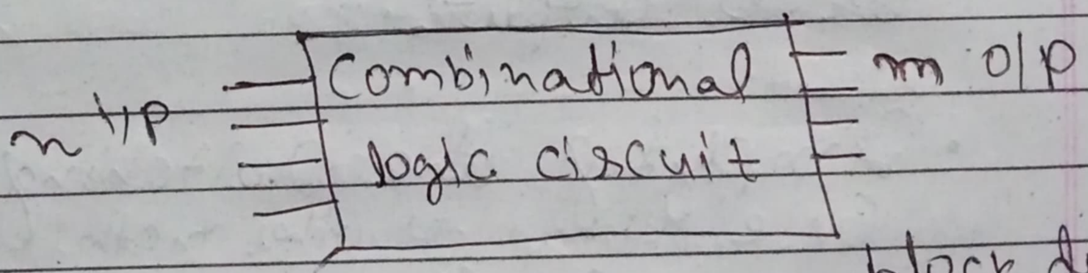
→ Combinational circuits:-

In this type of circuit, output of the circuit only depended ~~only~~ upon input values.

It does not use any memory.

It is type of logic circuit.

It has n-input and will have m ~~corresponding~~ output.



block diagram

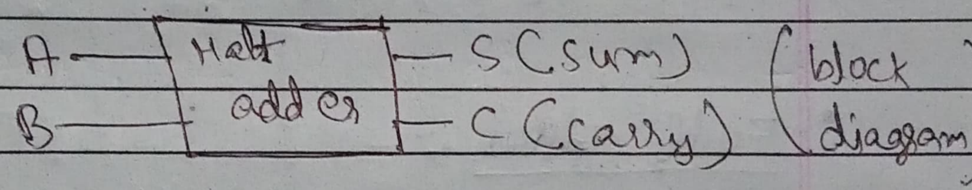
ex.- adder, subtractor, converter, encoder/decoder etc.

Steps to construct combinational logic circuit from boolean expression.

- From expression or problem, identify inputs and outputs and draw a block diagram.
- Draw a truth table such that the problem completely describes the operation of the circuit for different combination.
- Write down the switching expression ~~or~~ for outputs.
- Simplify the switching expression (use k-map or other method)
- Implement the simplified expression using logic gates.

- ## Half-adder :-

It is a simple combination of circuits to perform arithmetic addition of two binary digits.



T. T.

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

(Truth table)

we will only consider those condition in will result is '1'

so,

input (0 1) input (1 0)

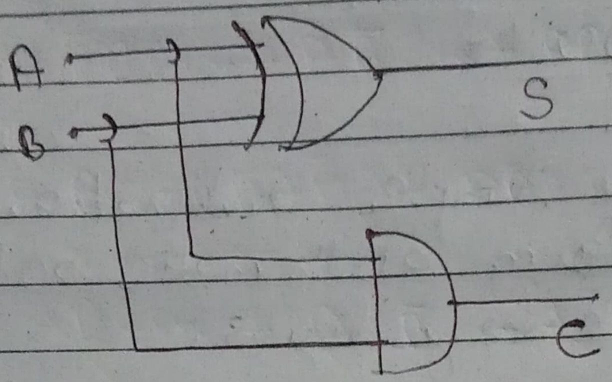
$$S = \bar{A}B + A\bar{B}$$

$$= A \oplus B$$

input (1, 1)

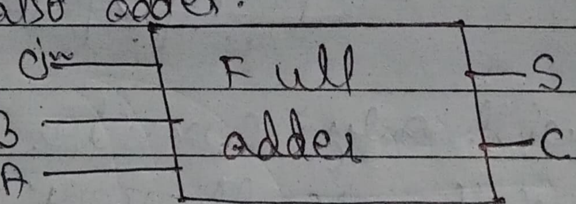
$$C = AB$$

(Switching expression for output)



• ## Full adder :-

It is combinational logic circuit in which 3 bit numbers are added and we get sum and carry as output.
In this problem lower order carry is also adder.



A, B → ~~Two input to add~~. Two significant bit.

Cin → carry of previous lower significant bit (A + B)

input			Output	
A	B	Cin	S	C
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

Switching expression of output is made by summing all input for which output is 1.

$$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + AB\bar{C}_{in}$$

$$= \bar{A}(\bar{B}C_{in} + B\bar{C}_{in}) + A(\bar{B}\bar{C}_{in} + BC_{in})$$

$$= \bar{A}(B \oplus C_{in}) + A(\overline{B \oplus C_{in}})$$

Let $B \oplus C_{in} = X$ —(1)

$$= \bar{A}X + A\bar{X}.$$

$$= A \oplus X$$

$$= A \oplus B \oplus C_{in} \quad \text{(from (1))}$$

$$C = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$

$$= BC_{in}(A + \bar{A}) + A\bar{B}C_{in} + AB\bar{C}_{in}$$

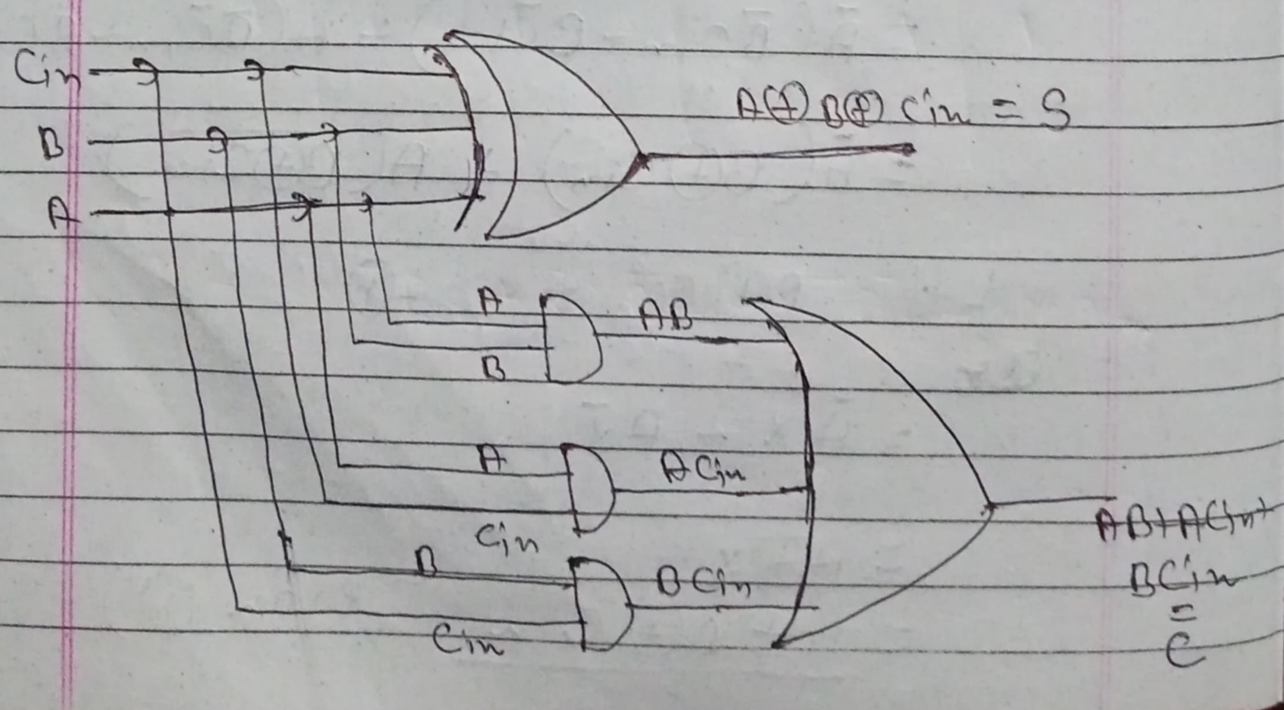
$$\cancel{= BC_{in} + A(\bar{B}C_{in} + B\bar{C}_{in})}$$

$$\cancel{= BC_{in} + A(B \oplus C_{in})}$$

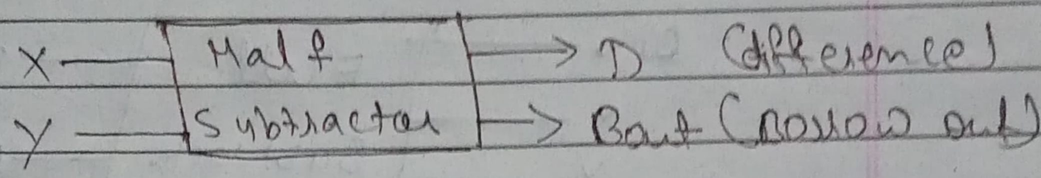
$$= BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in}$$

ABC_{in} term is twice added to simplify-

$$C = BC_{in} + A\bar{B}C_{in} + ABC_{in} + AB\bar{C}_{in} + ABC_{in}$$
$$= BC_{in} + AC_{in}(B + \bar{B}) + AB(\bar{C}_{in} + C_{in})$$
$$= BC_{in} + AC_{in} + AB$$



• Half Subtractor :-



T.T.

X	Y	D	Bout
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

so,

$D = \bar{X}Y + X\bar{Y}$

$= X \oplus Y$

$Bout = \bar{X}Y$