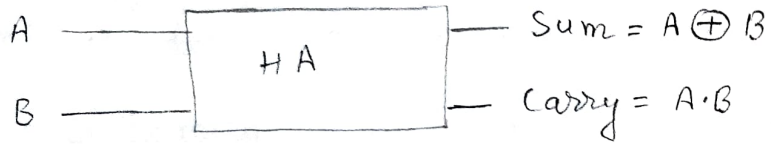
① Half-Adder

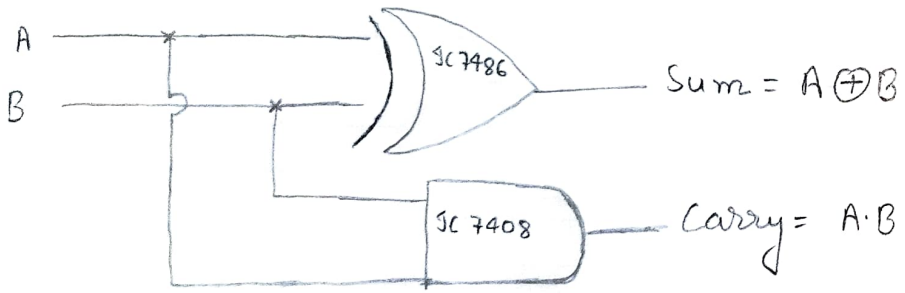
- Block diagram



- Truth table

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

- Logic diagram :-



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* Design and Implementation of full/half adder.

- Aim :- To design and very half and full adder using logic gates.

- Apparatus Required :-
  - IC 7404 (NOT gate)
  - IC 7408 (AND gate)
  - IC 7486 (XOR gate)
  - IC 7432 (OR gate).
  - Patch cards and trainer kit.

- Theory :-

① Half-Adder :- It is a combinational circuit that performs the addition of two data bits, A and B.

→ Addition will result in two output bits; one of which is the Sum bit, S and the other is the Carry bit, C.

→ The Boolean functions describing the half adder are :-

$$Sum = a \oplus b$$
$$Carry = a \cdot b$$

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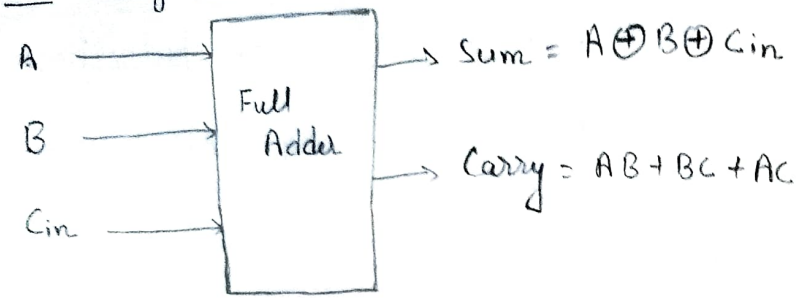
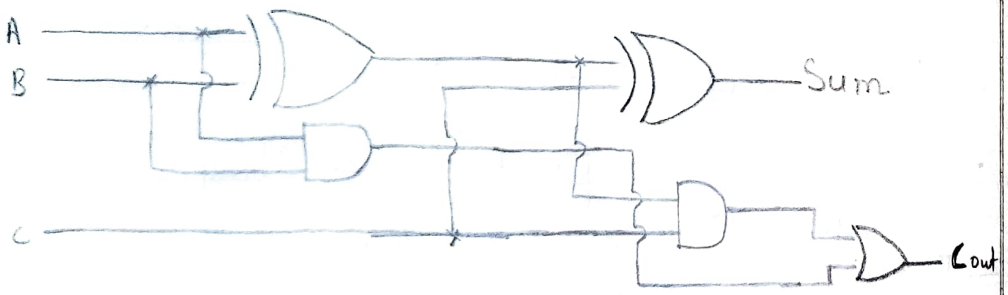
② Block Diagram :- (Full-adder)



- Truth Table :-

Input			Output	
A	B	Cin	Sum	C-out
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

- Logic Diagram



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② Full-Adder :- The half-adder does not take the carry bit from its previous stage into account.

→ This carry bit from its previous stage is called carry-in bit. A combinational logic circuit that adds two data bits, A and B, and a carry-in bit, Cin, is called full adder.

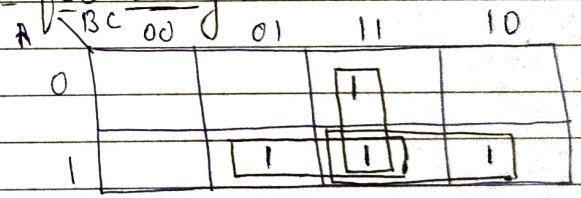
- Logical expression for Sum :-

= A'B'Cin + A'BCin + AB'Cin + ABCin

= Cin (A'B' + AB) + Cin (A'B + AB')

= Cin XOR (A XOR B).

- K-map for carry :-



Carry = AB + BC + AC.

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- Procedure :-

(a) Connections are given as per circuit diagram.
(b) Logical inputs are given as per circuit diagram.
(c) Observe the output are verify the truth table.

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* Design and implement of half / full subtractor

• Aim:- To design and verify half and full subtractor using logic gates.

• Apparatus required :-
- IC 7404 (NOT gate)
- IC 7408 (AND gate)
- IC 7486 (XOR gate)
- IC 7432 (OR gate)
- Patch cards and IC trainer kit.

• Theory :-

(a) Half-Subtractor :- Subtracting a single-bit binary value B from another A (i.e A-B) produces difference bit, D, and a borrow out bit B-out. This operation is called half-subtraction and the circuit to realize it is called a half-subtractor.

→ Boolean expression :-

$$D = A \oplus B$$

$$B_{out} = \bar{A} \cdot B$$

(b) Full subtractor :- It is a combinational circuit that perform subtraction of two bits A and B, with Borrow, Bin and produce a difference, D & Borrow.

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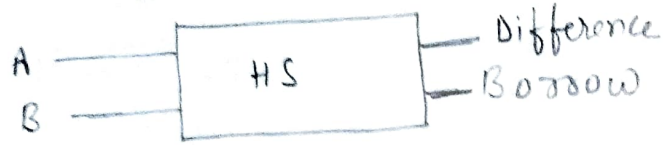
@ Half-Substractor

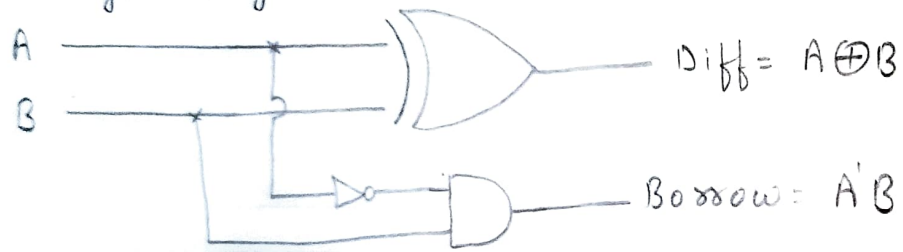
• Block Diagram :-



• Truth table

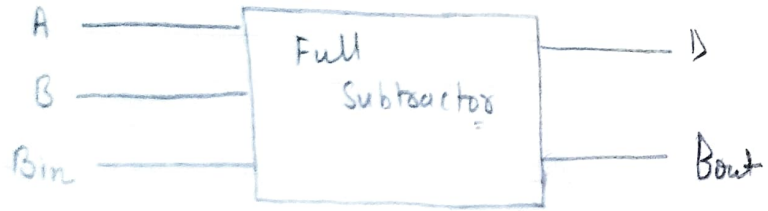
A	B	Diff.	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

• Logic diagram



(b) Full-Substractor

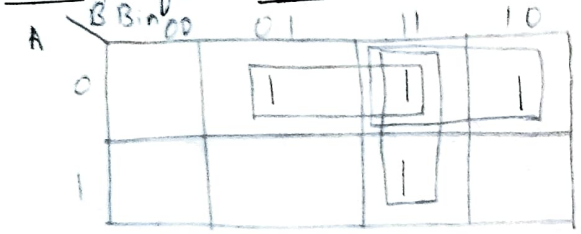
• Block Diagram :-



- Truth Table

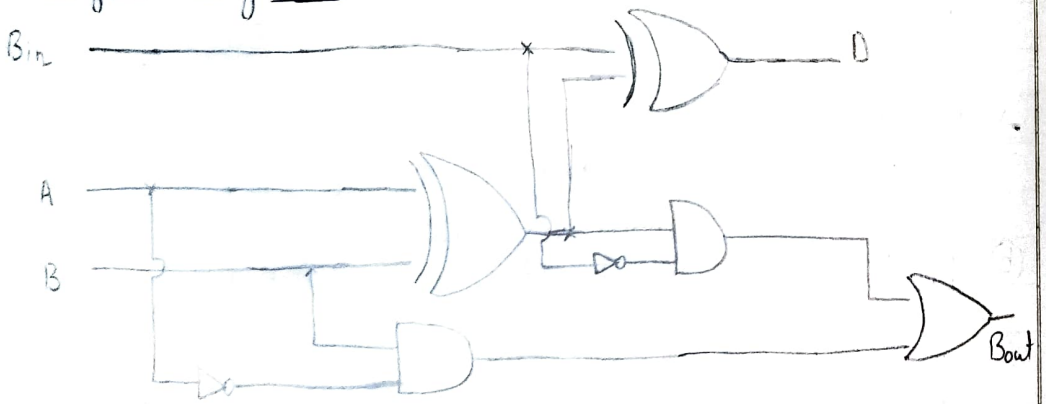
Input			Output	
A	B	Bin	D	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

- K-map for Bout



Bout = A'Bin + A'B + BBin

- Logic diagram :-



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- Boolean expression

= A'B'Bin + A'BBin + AB'Bin' + ABBin
= Bin (A'B' + AB) + Bin' (AB' + A'B)
= Bin (A XOR B)' + Bin' (A XOR B)
= Bin XOR (A XOR B)
= (A XOR B) XOR Bin.

- Procedure :-

(i) Connections are given as per circuit diagram.
(ii) Logical inputs are given as per circuit diagram.
(iii) Observe the output and verify the truth table.

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