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EXPERIMENT - 4

* AIM:

- To verify the truth table of half subtractor by using the IC's of XOR, NOT and AND gates and of full subtractors by using the IC's of XOR, AND, NOT and OR gates respectively and analyse the working of half subtractor and full subtractor and verify the truth tables of half subtractor and full subtractor in simulation 2

* THEORY:

Subtractor circuits take two binary numbers as input and subtract one binary number input from the other binary number input. Similar to adders, it gives out two outputs, difference and borrow (carry in the case of adders). There are two types of subtractors:

- Half subtractor
- Full subtractor

→ Half Subtractor

- The half subtractor is a combinational circuit which is used to perform subtraction of two bits. It has two inputs, the minuend X and subtractend Y; and two outputs difference D and borrow out Bout. The borrow out signal is set when the subtractor needs to borrow from the next digit in a multi-digit subtraction. That is, Bout = 1 when X < Y. Since X and Y are bits, Bout = 1 if and only if X = 0 and Y = 1. An important point worth mentioning is that the half subtractor diagram aside, implements X - Y

and not Y-X. since Bout on the diagram is given by

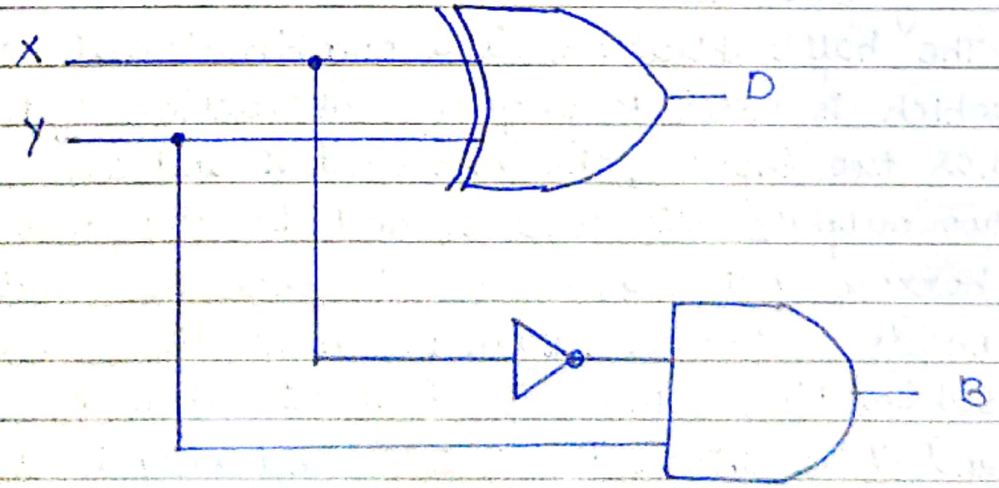
$B_{out} = \bar{X} \cdot Y$

This point is important since subtraction itself is not commutative, but the difference bit D is calculated using an XOR gate which is commutative.

→ TRUTH TABLE FOR HALF-SUBTRACTOR

Inputs		outputs	
X	Y	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

→ CIRCUIT DIAGRAM OF HALF SUBTRACTOR



→ FULL SUBTRACTOR

The full subtractor is a combinational circuit which is used to perform subtraction of three input bits. The minuend A, the subtractend B and borrow in Bin. The full subtractor generates two output bits: the difference D and borrow out Bout. Bin is set when the ~~digit~~ previous digit is borrowed from A. Thus Bin is also subtracted from A as well as the subtrahend B. Or in symbols. A - B - Bin. Like the half subtractor, the full subtractor generates a borrow out when it needs to borrow from the next digit. Since we are subtracting B and Bin from A, a borrow out needs to be generated where A < B + Bin. When a borrow out is generated, 2 is added in the current digit. Therefore

$D = A - B - Bin + 2Bout$

→ TRUTH TABLE OF FULL SUBTRACTOR

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

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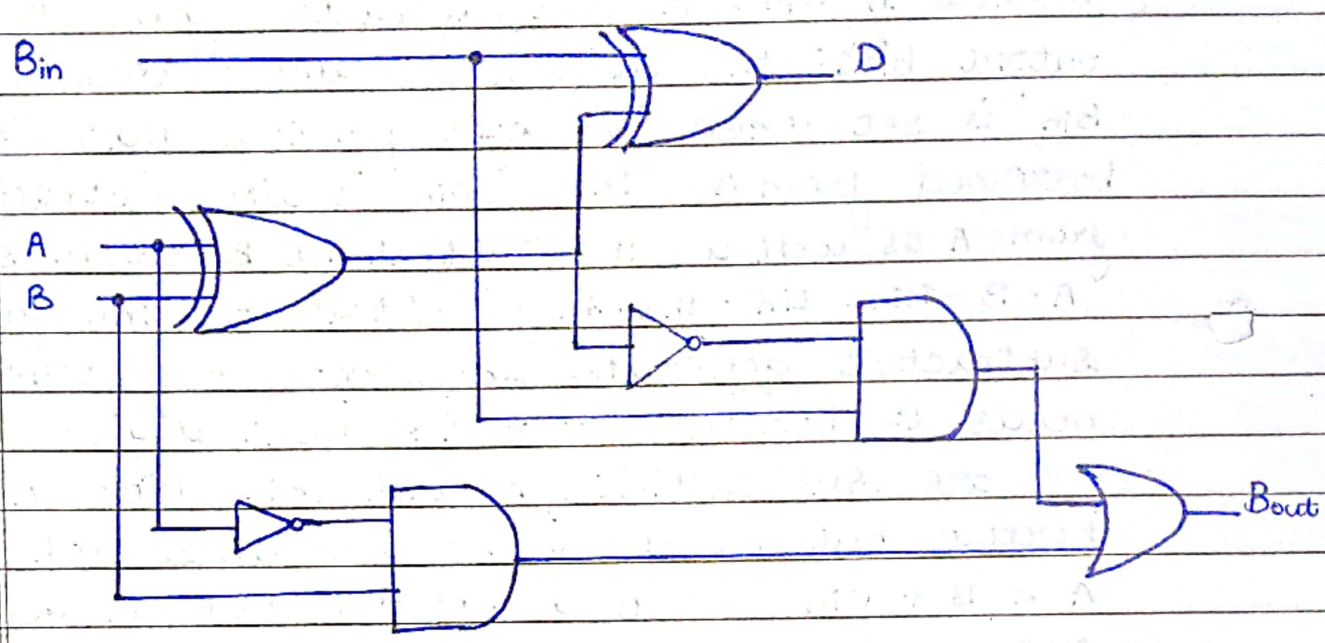
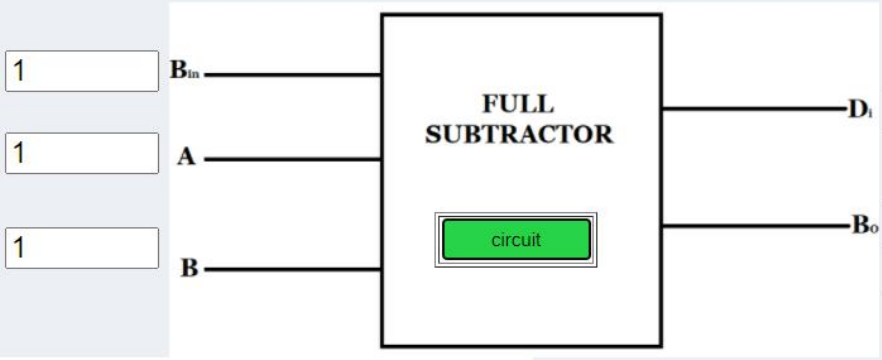
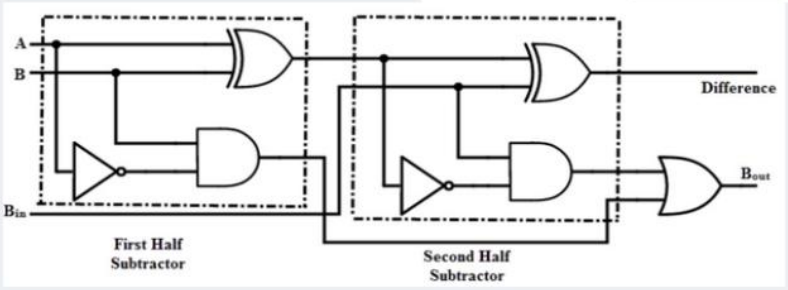
→ CIRCUIT DIAGRAM OF FULL SUBTRACTOR



Verification of truth table for Full Subtractor Circuit



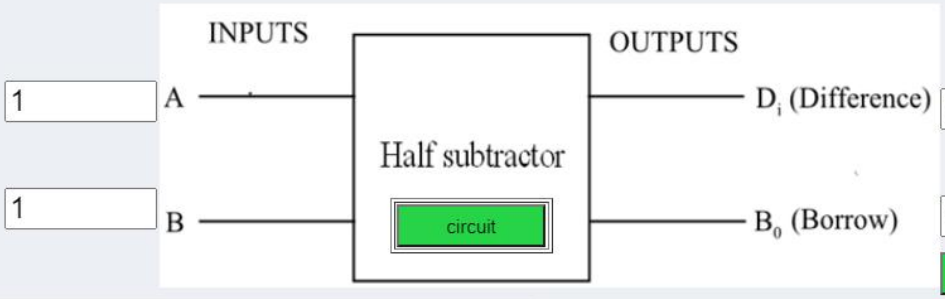


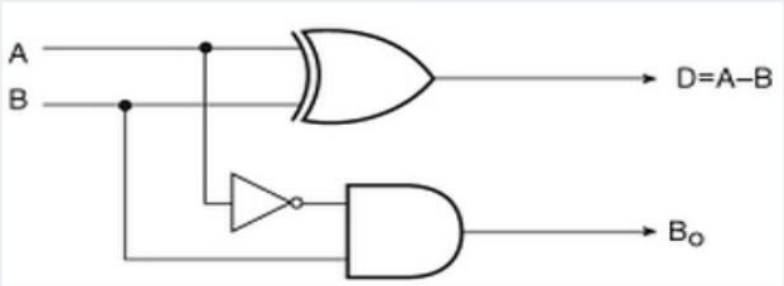
Reset

TRUTH TABLE Print

Serial No.	A	B	Bin	Diffrence	Bout	Remarks
1	0	0	0	0	0	Correct
2	0	0	1	1	1	Correct
3	0	1	0	1	1	Correct
4	0	1	1	0	1	Correct
5	1	0	0	1	0	Correct
6	1	0	1	0	0	Correct
7	1	1	0	0	0	Correct
8	1	1	1	1	1	Correct

Verification of truth table for Half Subtractor Circuit





Reset

TRUTH TABLE

Print

Serial No.	A	B	Sub	Borrow	Remarks
1	0	0	0	0	Correct
2	0	1	1	1	Correct
3	1	0	1	0	Correct
4	1	1	0	0	Correct