Experiment 4

Aim - To design, simulate and verify

i) Half -Subtractor
ii) Full-Subtractor using 2 half subtractors and NAND gates

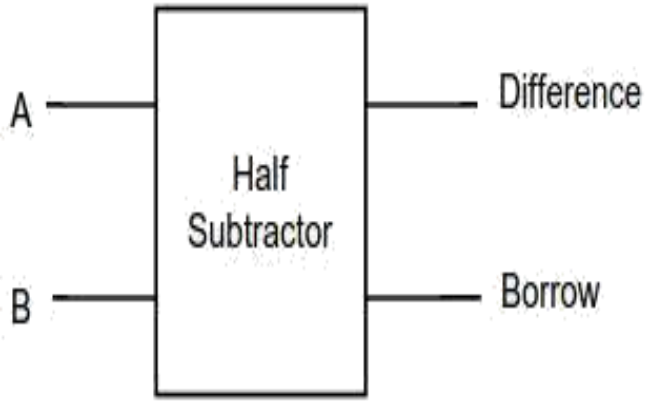
Platform Used – Circuit-Verse

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 Adder). There are two types of subtractors.

1. Half Subtractor
2. Full Subtractor

1) Half Subtractor

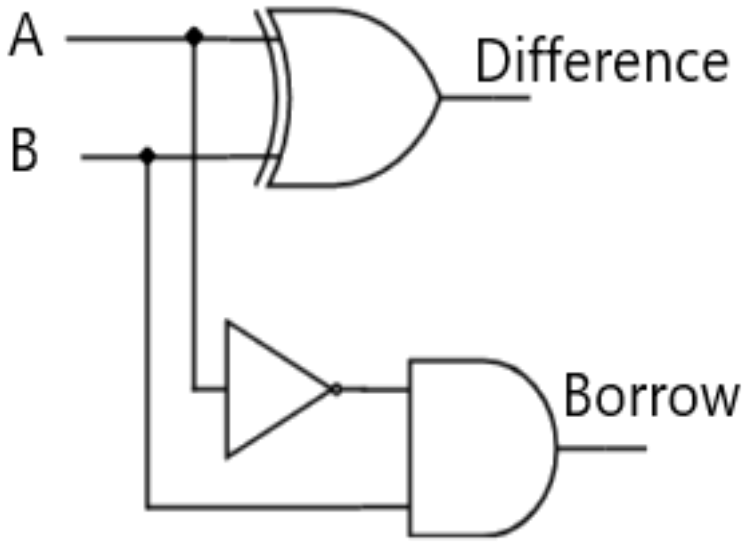
The half-subtractor is a combinational circuit which is used to perform subtraction of two bits. It has two inputs, A (minuend) and B (subtrahend) and two outputs Difference and Borrow. The logic symbol and truth table are shown below.



Logic Symbol of Half subtractor

Inputs		Outputs	
A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Truth Table of Half subtractor



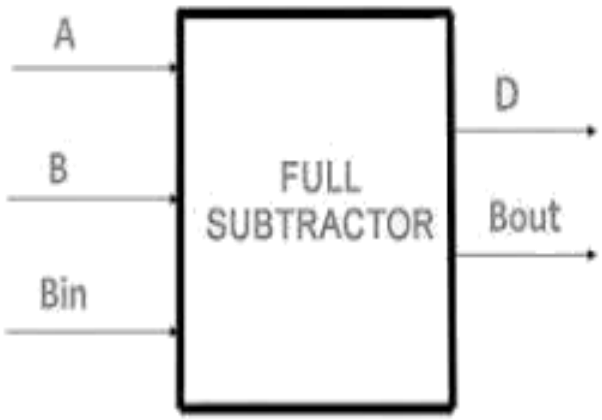
Circuit Diagram of Half subtractor

From the above truth table, we can find the Boolean expression.

Difference = A ⊕ B Borrow = A' B

From the equation we can draw the half-subtractor circuit as shown in the figure.

Full Subtractor: -A full subtractor is a combinational circuit that performs subtraction involving three bits, namely A (minuend), B (subtrahend), and Bin (borrow-in) . It accepts three inputs: A (minuend), B (subtrahend) and a Bin (borrow bit) and it produces two outputs:
D (difference) and Bout (borrow out). The logic symbol and truth table are shown below.



Logic Symbol of Full subtractor

A	B	B_{in}	D	B_{out}
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

Truth Table of Full subtractor

For D

A \ BB_{in}	00	01	11	10
0	0	(1)	0	(1)
1	(1)	0	(1)	0

$D = \overline{A}\overline{B}B_{in}+\overline{A}B\overline{B}_{in}+A\overline{B}\overline{B}_{in}+ABB_{in}$

For B_{out}

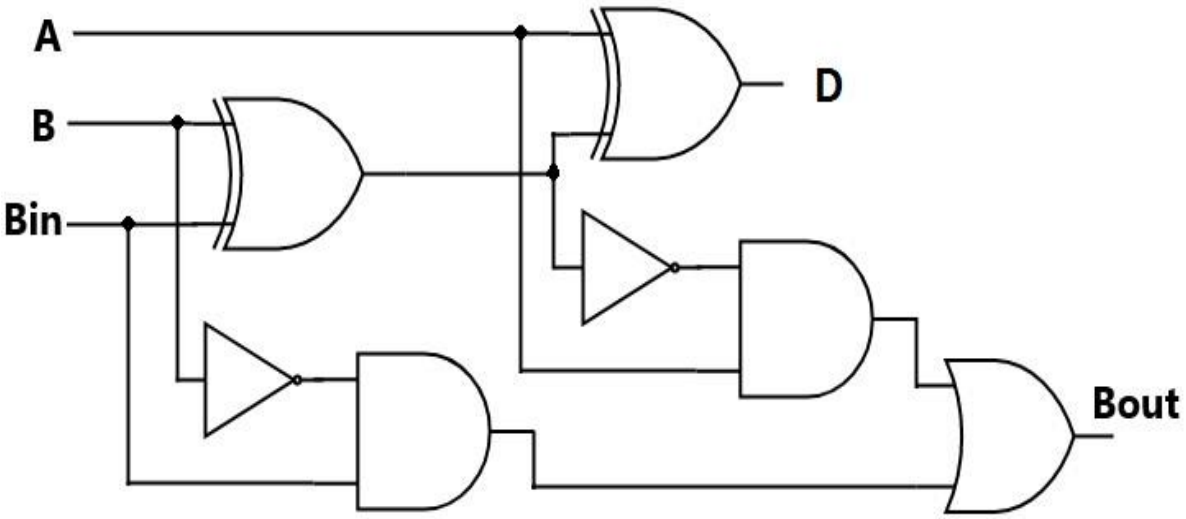
A \ BB_{in}	00	01	11	10
0	0	1	1	1
1	0	0	1	0

$B_{out} = \overline{A}B_{in}+\overline{A}B+BB_{in}$

From the above truth table, we can find the Boolean expression.

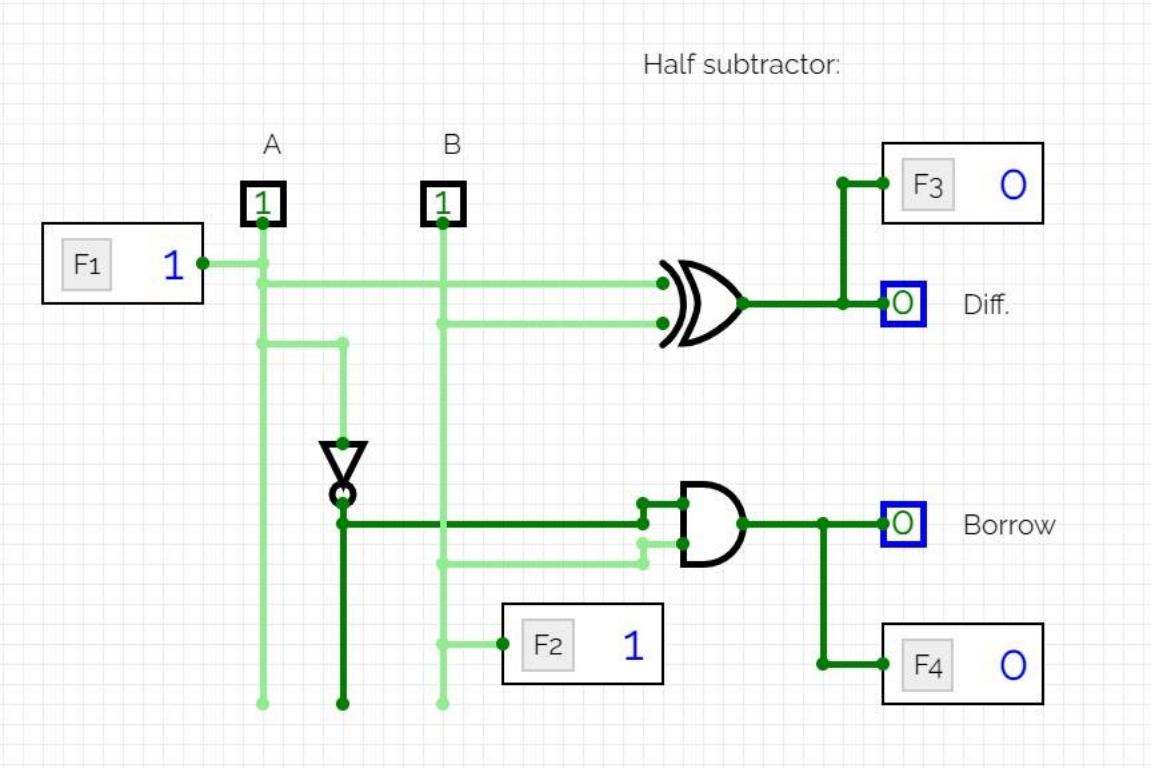
D = A ⊕ B ⊕ Bin Bout = A' Bin + A' B + B Bin

From the equation we can draw the Full-subtractor circuit as shown in the figure 6.

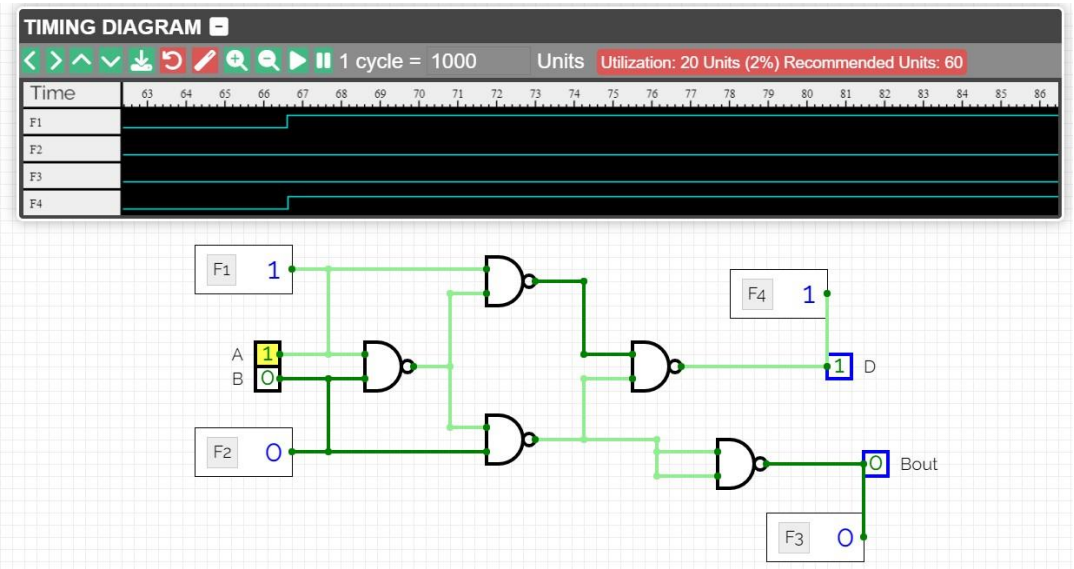


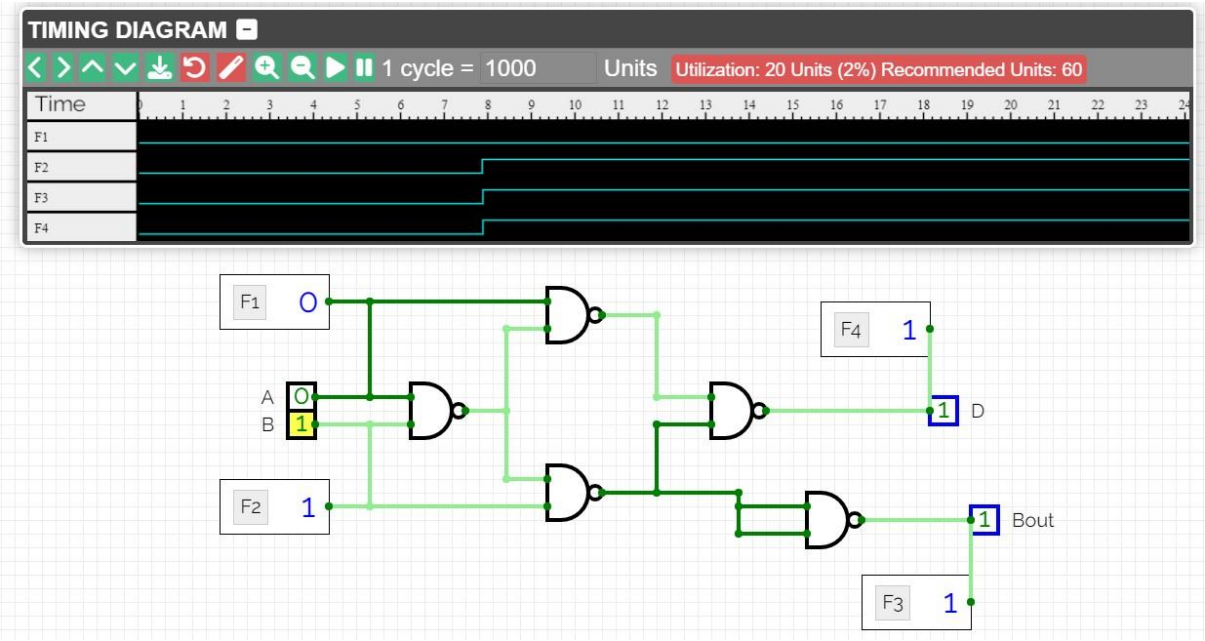
Circuit Diagram of Full subtractor

Simulated Output- Half-Subtractor: -

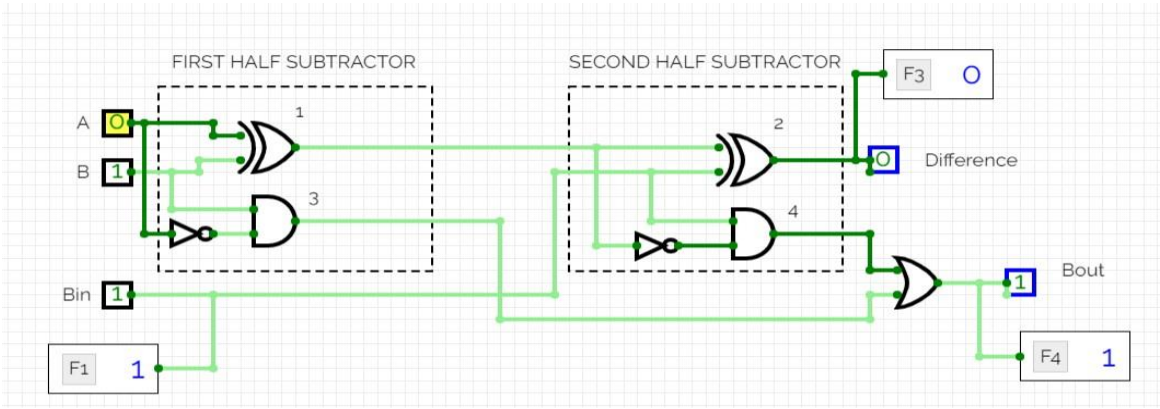


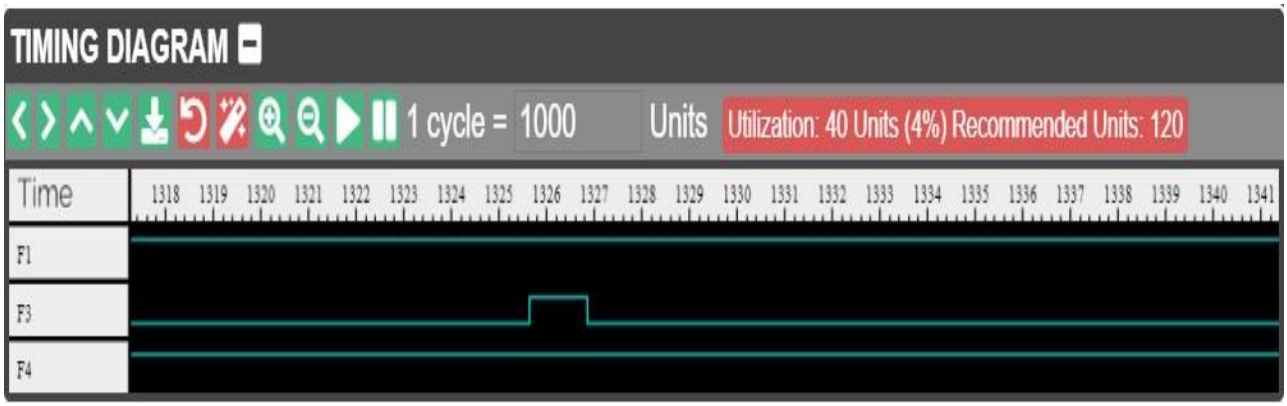
Half-Subtractor Using NAND Gate: -



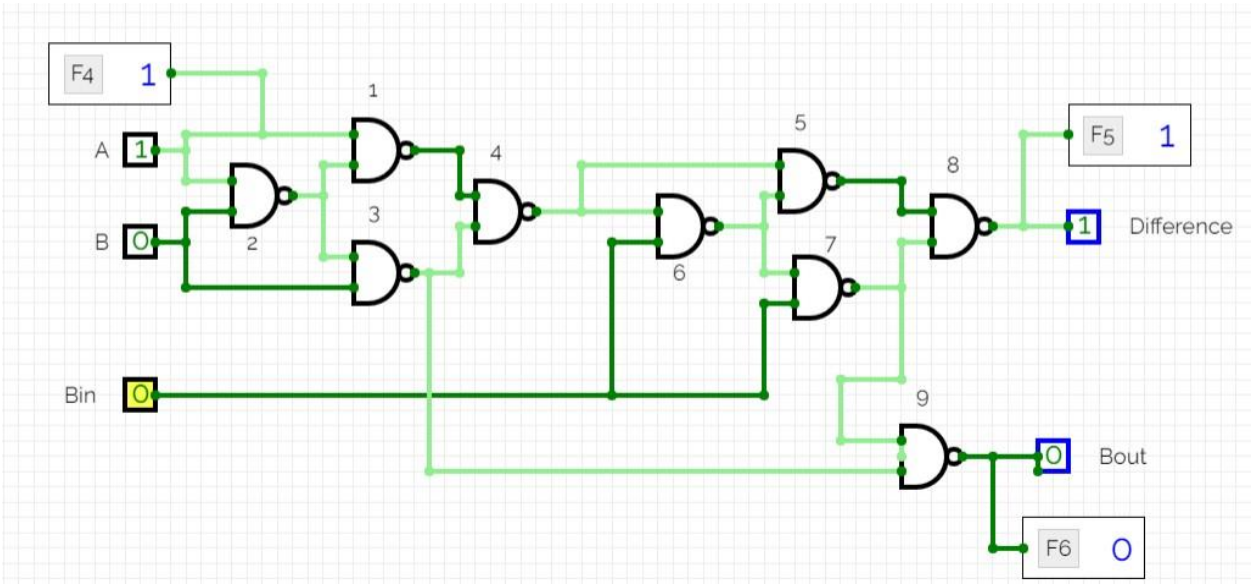


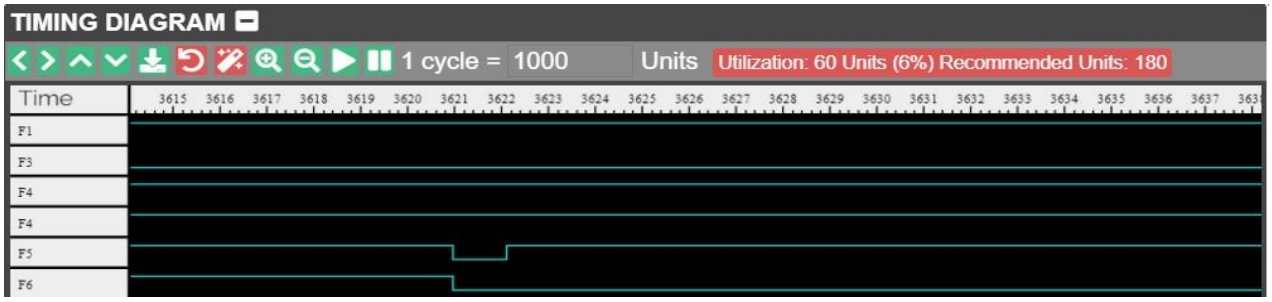
Full-Subtractor using 2 half-Subtractors: -





Full-Subtractor using NAND gates:





RESULT: The Half-Subtractor combinational circuit and full-subtractor combinational circuit using 2 half subtractors and NAND gates have been designed, simulated and verified.