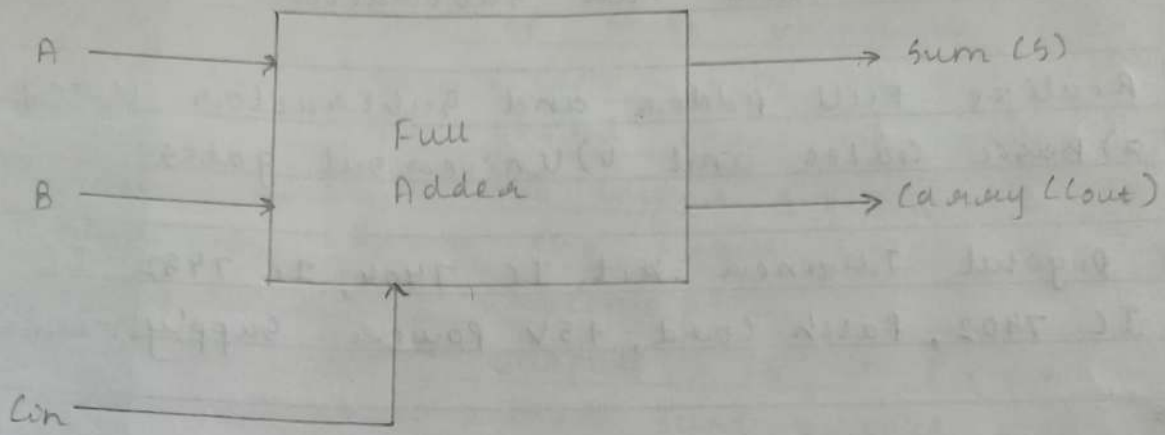
Assignment no-1

Title: Full Adder and Full Subtractor

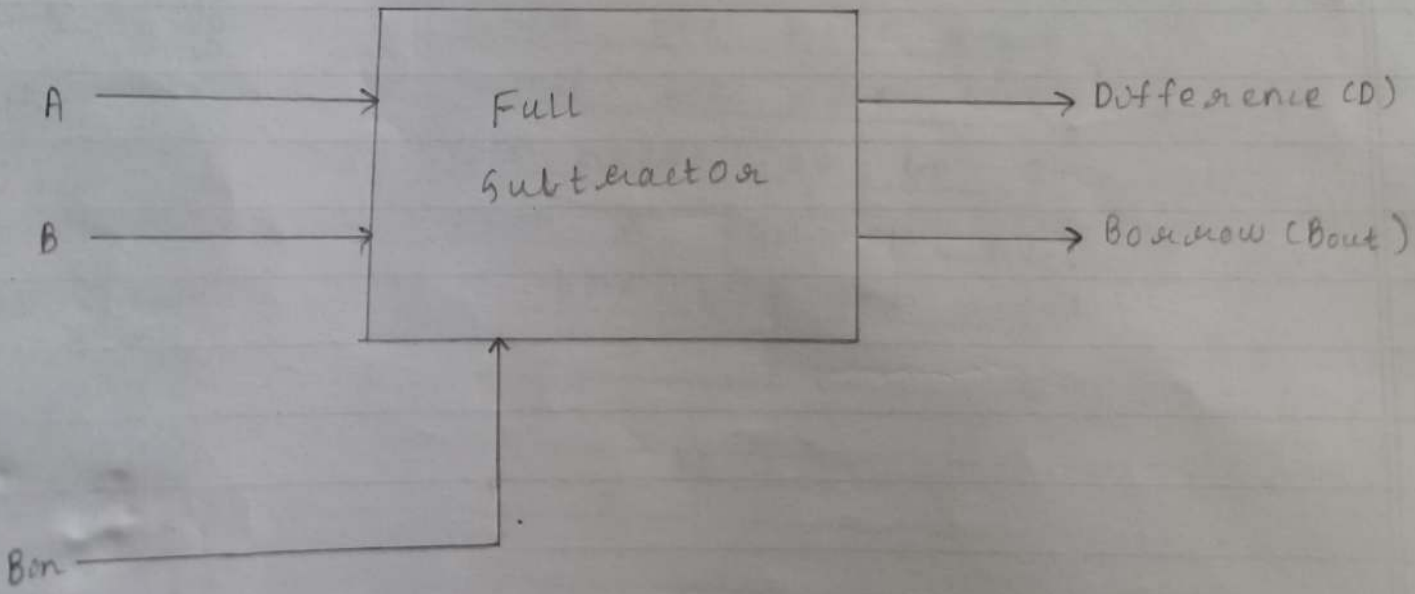
Problem Statement: Realize Full Adder and Subtractor Using a) Basic Gates and b) Universal gates

Hardware and Software Requirements: Digital Trainer kit, IC 7404, IC 7432, IC 7408, IC 7400, IC 7402, Patch Cord, +5V Power Supply

Theory: Full Adder : (with block diagram)
Full Subtractor : (with block diagram)
Universal Gates



Block diagram of Full Adder



Block diagram of Full Subtractor

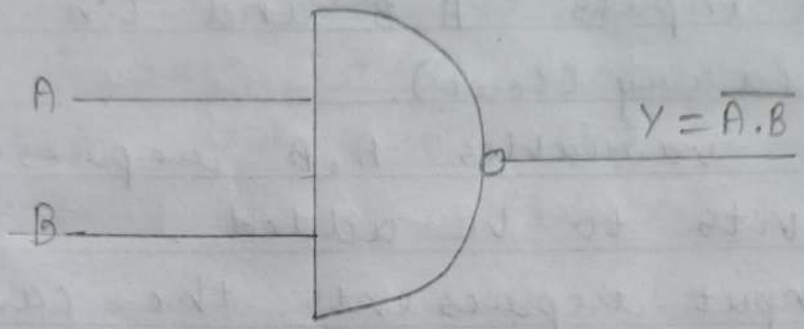
→ Full Adder :-

- A full adder is a combinational logic circuit that has 3 inputs A, B and Cin and 2 outputs Sum and Carry (Cout).
- Two of these variables A, B represent the two significant bits to be added.
- The third input represents the carry from previous lower significant position.
- From the truth table, the full adder logic can be implemented.
- The output S is an Ex-or between the input A and half-adder Sum output with B and Cin inputs.
- Cout will only be true if any of the two inputs out of the three are HIGH.

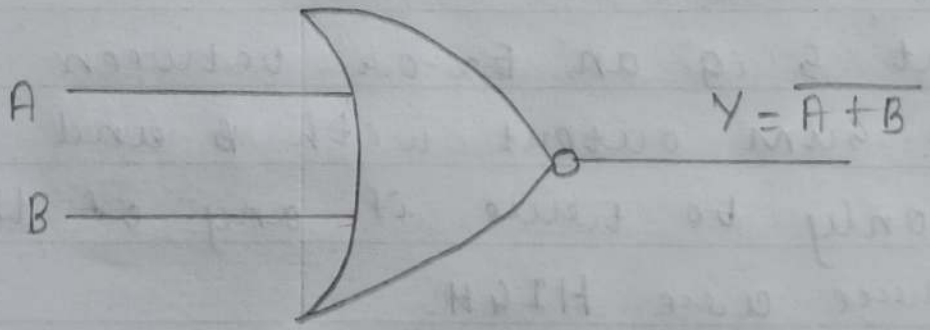
→ Full Subtractor :-

- A full subtractor is a combinational logic circuit with 3 inputs A, B and Bin and 2 outputs difference and Borrow (Bout).
- Like the half subtractor, the full subtractor generates a borrow out when it needs to borrow from the next digit.
- Since we are subtracting by and, a borrow out needs to be generated when. ~~a borrow~~
- When a borrow out is generated, 2 is added in the current digit.

→ Universal Gates



NAND Gate



NOR Gate

Universal Gates:-

A universal gate is a gate which can implement any boolean ~~function~~ function without need to use any other gate type.

The NAND and NOR gates are universal gates. In practice, this is advantageous since NAND and NOR gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families.

→ Design :-

1. Full Adder

- Truth table

A	B	Cin	S (sum)	Cout (Carry)
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

- K-map

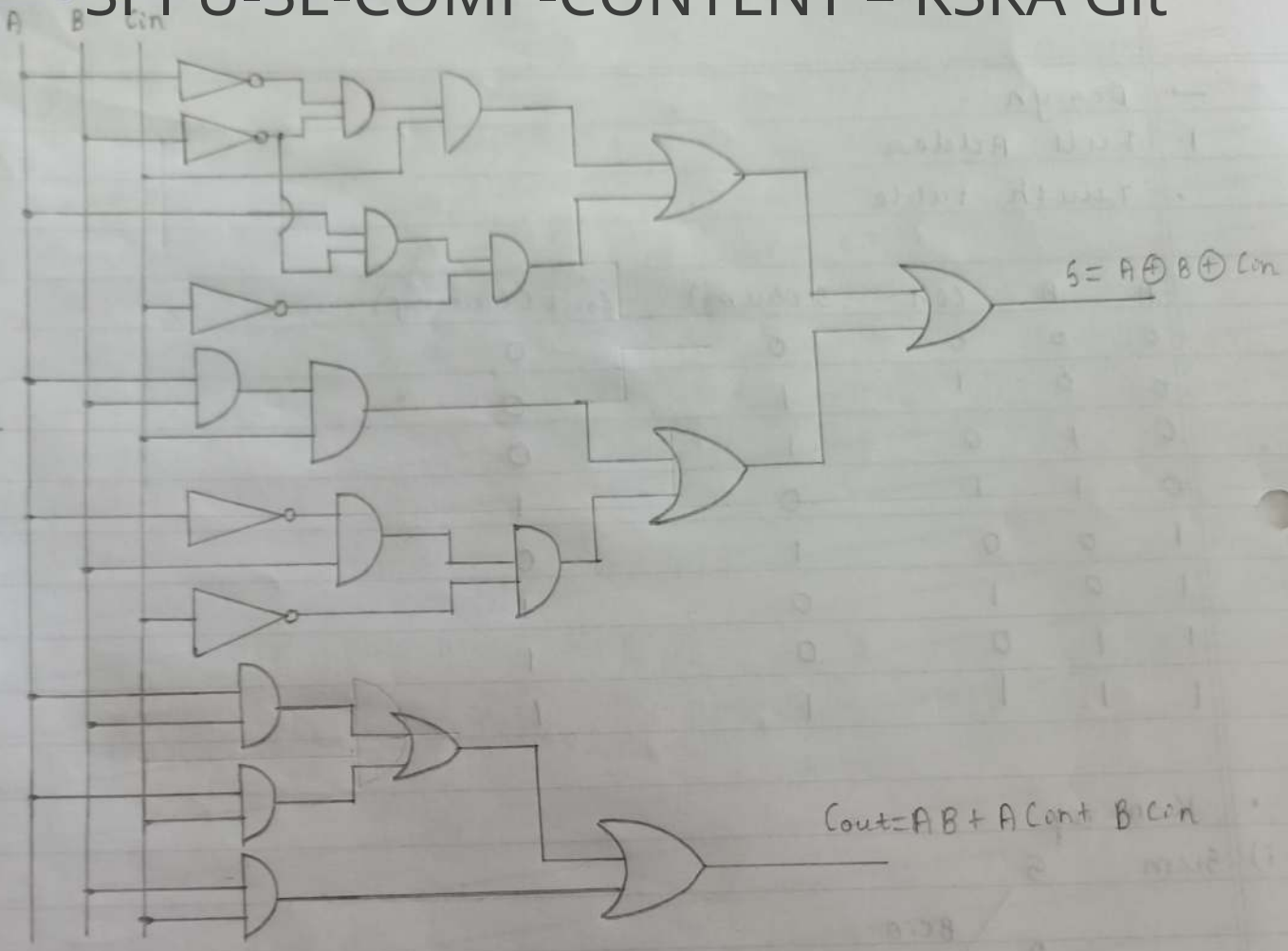
i) Sum S

A \ BCin	$\bar{B}\bar{C}in$	$\bar{B}Cin$	$BCin$	$B\bar{C}in$
$\bar{A}$	0 (0)	1 (1)	0 (3)	1 (2)
A	1 (4)	0 (5)	1 (7)	0 (6)

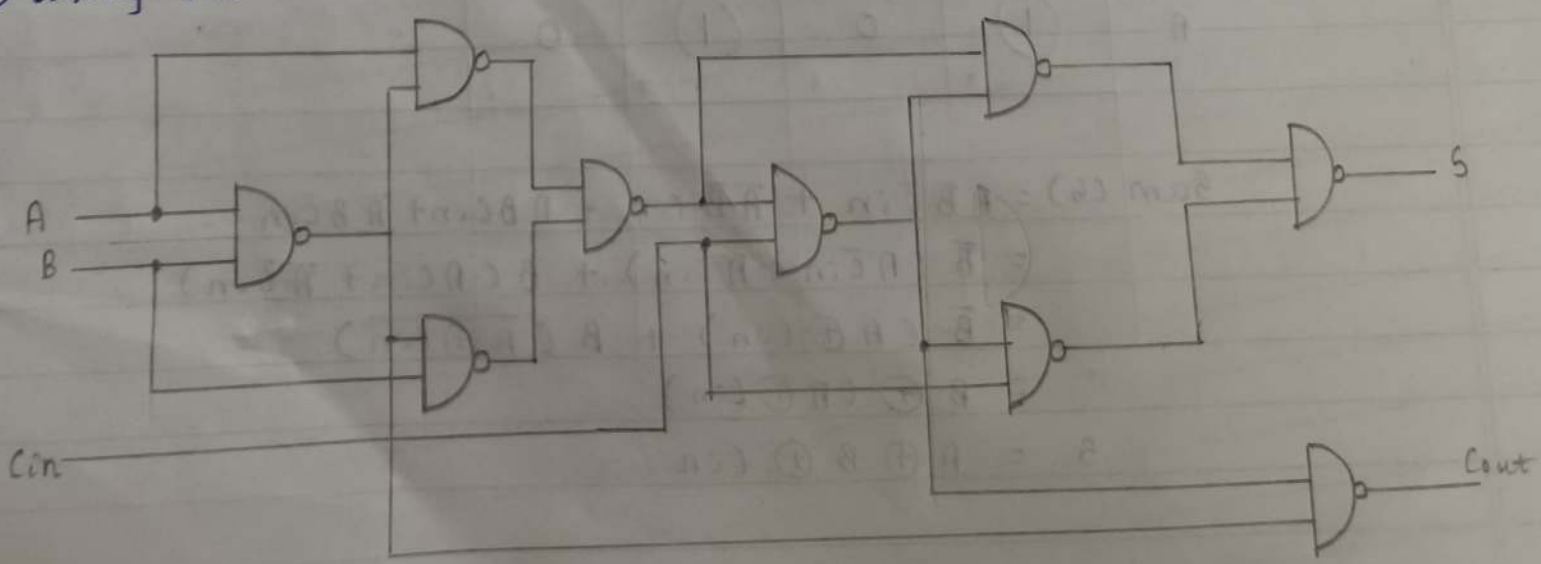
$$Sum(S) = A\bar{B}\bar{C}in + \bar{A}\bar{B}Cin + ABCin + \bar{A}B\bar{C}in$$
$$= \bar{B}(A\bar{C}in + \bar{A}Cin) + B(ACin + \bar{A}\bar{C}in)$$
$$= \bar{B}(A \oplus Cin) + B(\overline{A \oplus Cin})$$
$$= B \oplus (A \oplus Cin)$$
$$S = A \oplus B \oplus Cin$$

→ Circuit diagram

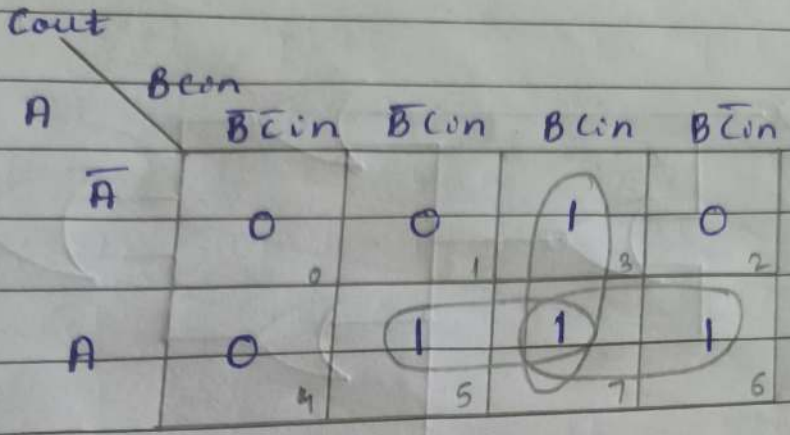
1) Using Basic Gates



2) Using NAND Gate

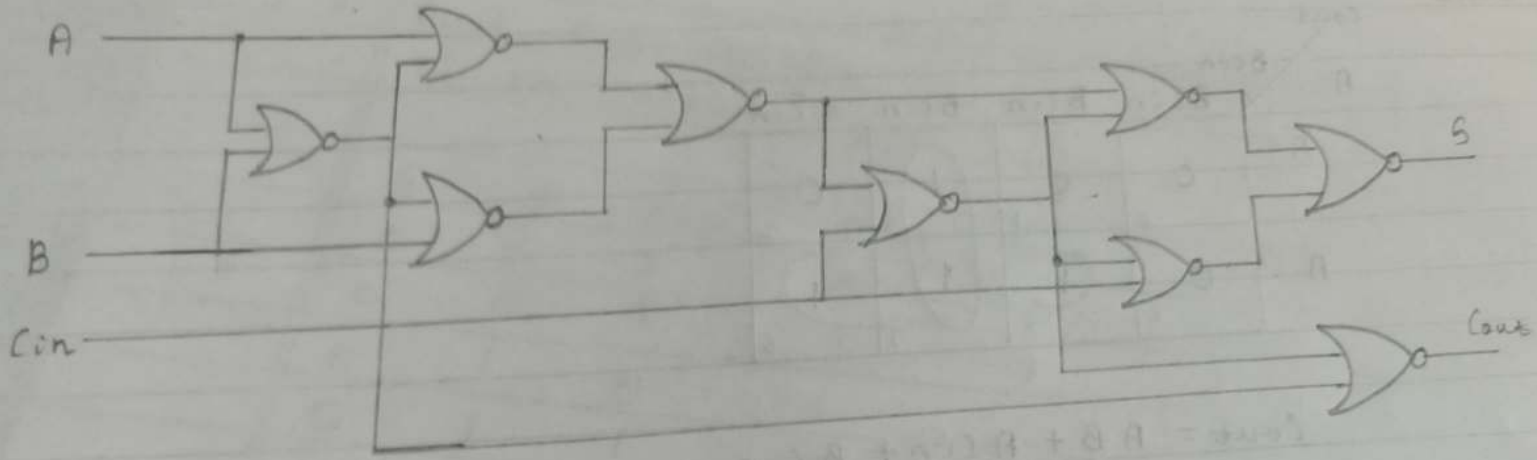


ii) Cout



$Cout = AB + ACin + BCin$

3) Using NOR Gate



2. Full Subtractor

- Truth ~~Tabble~~ Table

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

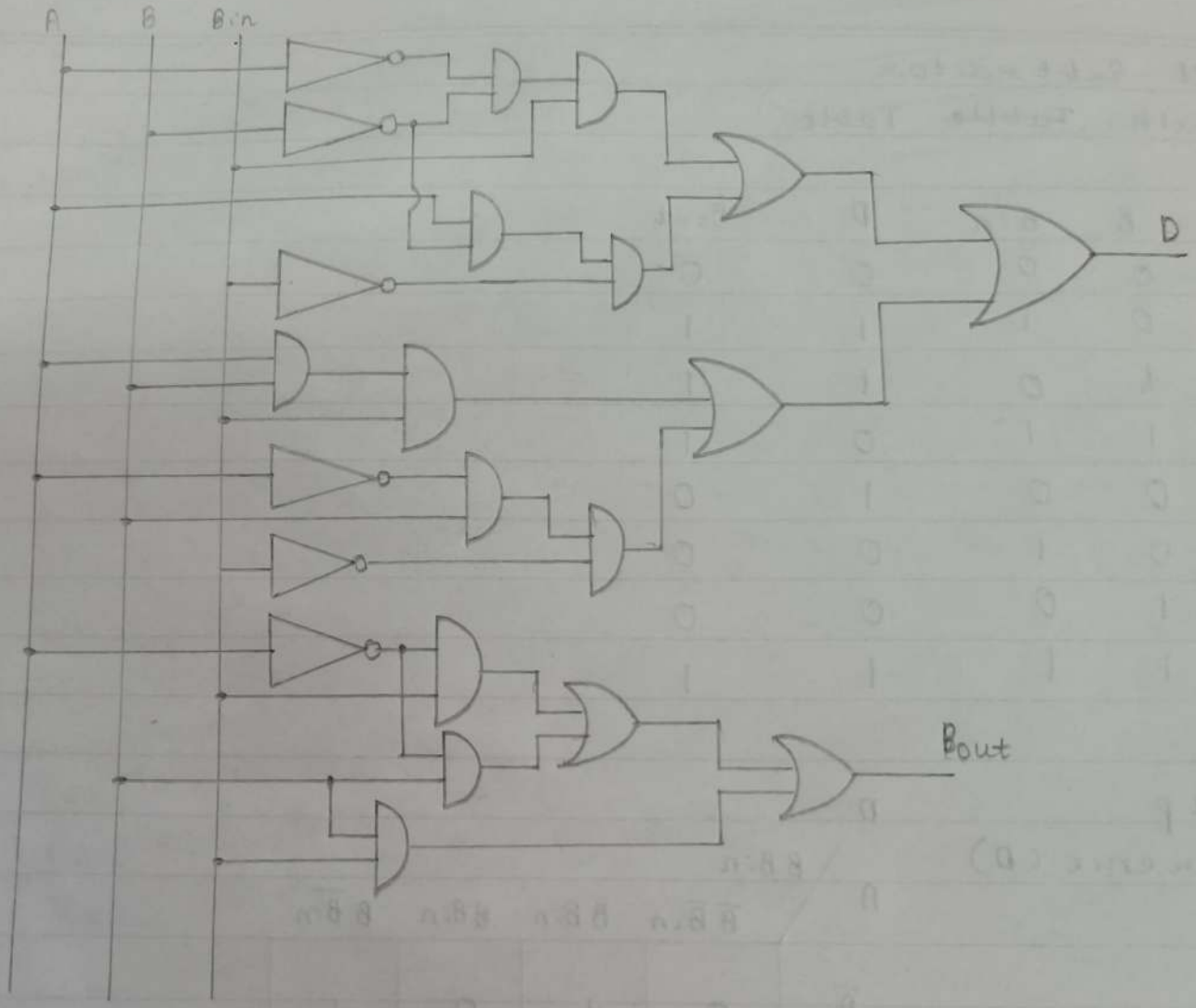
i) Difference (D)

D: A \ B Bin	$\bar{B}\bar{B}in$	$\bar{B}B in$	$BB in$	$B\bar{B}in$
$\bar{A}$	0 (0)	1 (1)	0 (3)	1 (2)
A	1 (4)	0 (5)	1 (7)	0 (6)

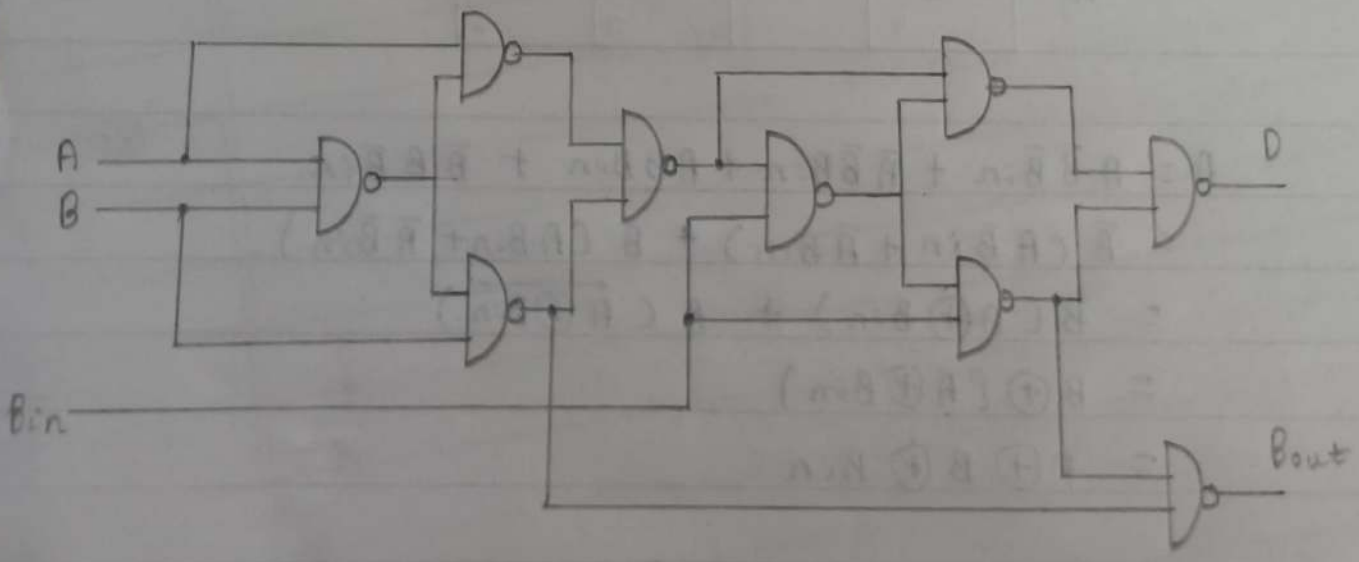
$$D = A\bar{B}\bar{B}in + \bar{A}\bar{B}Bin + ABBin + \bar{A}B\bar{B}in$$
$$= \bar{B}(A\bar{B}in + \bar{A}Bin) + B(ABin + \bar{A}\bar{B}in)$$
$$= \bar{B}(A \oplus Bin) + B(\overline{A \oplus Bin})$$
$$= B \oplus (A \oplus Bin)$$
$$= A \oplus B \oplus Bin$$

→ Circuit Diagram

1) Using Basic Gates



2) Using NAND Gate



ii) Borrow (Bout)

A \ B Bin	$\bar{B}\bar{B}in$	$\bar{B}B in$	$BB in$	$B\bar{B}in$
$\bar{A}$	0 (0)	1 (1)	1 (3)	1 (2)
A	0 (4)	0 (5)	1 (7)	0 (6)

$$Bout = \bar{A}Bin + \bar{A}B + BBin$$

→ Conclusion:

- Realized Full Adder and Subtractor using Basic and Universal Gates.

3) Using NOR Gate