Experiment No. 04

Name of the experiment: Construct and test various adder and subtractor circuits.

Objective: To realize the adder and subtractor circuits using basic gates and universal gates

To realize full adder using two half adders.

To realize a full subtractor using two half subtractors.

Components Required:

IC 7400, IC 7408, IC 7486, IC 7432, Patch Cords & IC Trainer Kit.

Theory:

Half-Adder: A combinational logic circuit that performs the addition of two data bits, A and B, is called a half-adder. 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:

$$S = A \oplus B \quad C = A\,B$$

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 a full-adder. The Boolean functions describing the full-adder are:

$$S = (x \oplus y) \oplus Cin \quad C = xy + Cin\,(x \oplus y)$$

Half Subtractor: Subtracting a single-bit binary value B from another A (i.e. A -B) produces a 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. The Boolean functions describing the half Subtractor are:

$$S = A \oplus B \quad C = A'\,B$$

Full Subtractor: Subtracting two single-bit binary values, B, Cin from a single-bit value A produces a difference bit D and a borrow out Br bit. This is called full subtraction. The Boolean functions describing the full-subtractor are:

$$D = (x \oplus y) \oplus Cin \quad Br = A'B + A'(Cin) + B(Cin)$$

Truth Table& Logic Diagram: To realize Half Adder

TRUTH TABLE

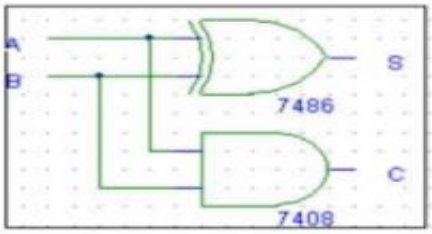
INPUTS		OUTPUTS	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

BOOLEAN EXPRESSIONS:

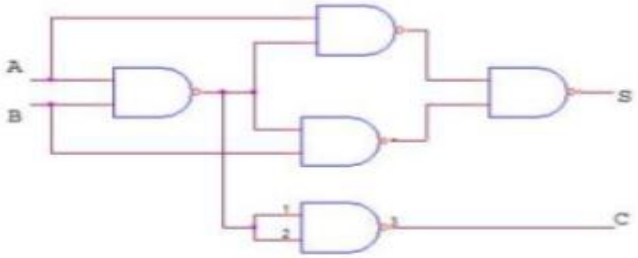
$S = A \oplus B$

$C = A\ B$

i) Basic Gates



ii) NAND Gates



Full Adder:

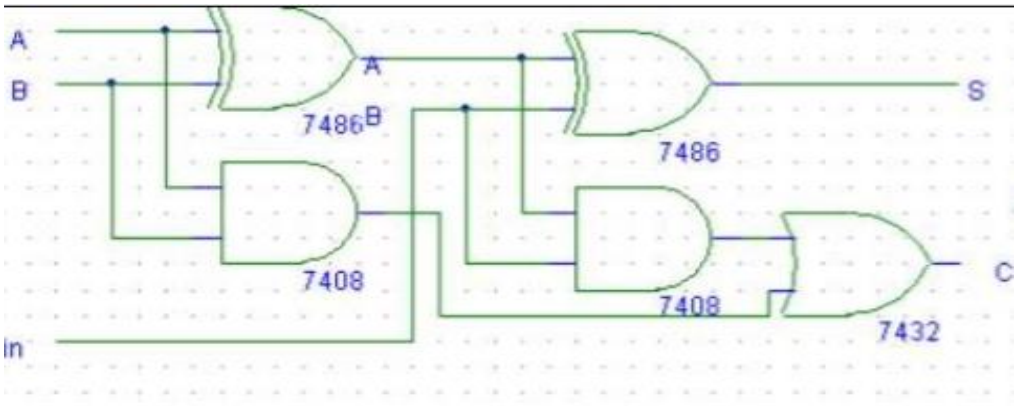
TRUTH TABLE

INPUTS			OUTPUTS	
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

BOOLEAN EXPRESSIONS:

$S = A \oplus B \oplus C$

$C = A\ B + B\ Cin + A\ Cin$



Half Subtractor :

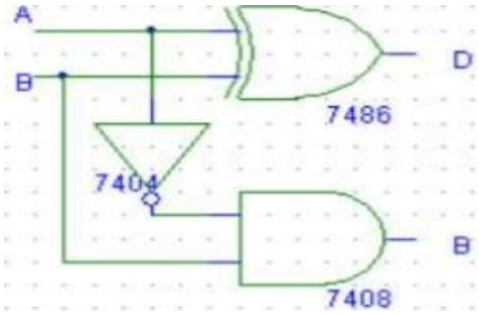
TRUTH TABLE

INPUTS		OUTPUTS	
A	B	D	Br
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

BOOLEAN EXPRESSION

$D = A \oplus B$

$Br = \bar{A}B$



Full subtractor:

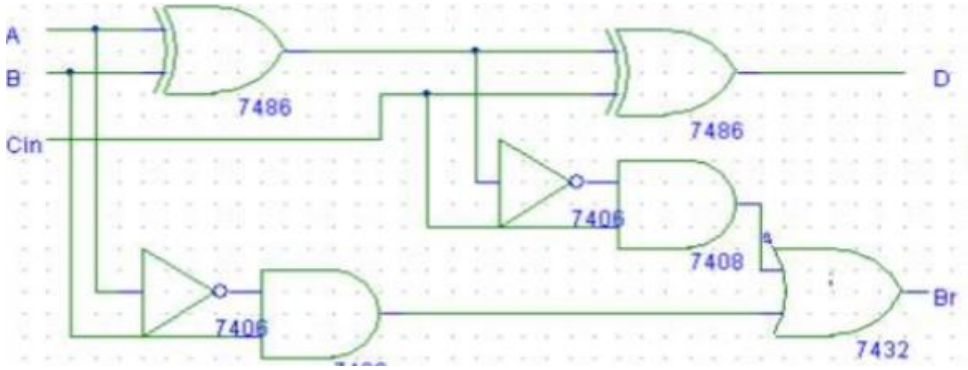
TRUTH TABLE

INPUTS			OUTPUTS	
A	B	Cin	D	Br
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

BOOLEAN EXPRESSIONS:

$$D = A \oplus B \oplus C$$

$$Br = \bar{A}\ B + B\ Cin + \bar{A}\ Cin$$



Procedure:

1. Check the components for their working.
2. Insert the appropriate IC into the IC base.
3. Make connections as shown in the circuit diagram.
4. Provide the input data via the input switches and observe the output on output LEDs

Discussion:

The adder is divided in to types full and half adder the half adder add two bit numbers and the full adder add two bits and a carry.

The subtractor is also divided into half and full were the half subtract two bits and the full subtract two bits and a borrow.