



LAB REPORT

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Computer Science and Engineering

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Section : B

Semester : 2nd Semester

Experiment No : 03



①
Experiment name : Adders & Subtractors.

Aim : To realize

(i) Half Adder and Full Adder

(ii) Half Subtractor and Full Subtractor

Learning objective : To realize

(i) The adder and subtractor circuits using basic gates and universal gates.

(ii) Full Adder using two half-adder.

(iii) Full Subtractor using two half-subtractor.

Components Required:

IC 7400, IC 7408, IC 7486, IC 7432, Patch cards, and IC Trainer kit.

Theory:

Half-Adder: Half adder is a combinational logic circuit that performs addition of two data bits (A & B). Output bits are sum bit (S) & carry bit (C₀). The Boolean Functions describing half-adder are,

$$S = A \oplus B = A\bar{B} + \bar{A}B$$

$$C_0 = AB$$

(2)

Full-Adder: A combinational logic circuit that adds two data bits (A, B) and a carry bit C_i from its previous states. The boolean functions describing the full adder are

$$S = A \oplus B \oplus C_i$$

$$C_o = AB + C_i(A \oplus B)$$

Half Subtractor: Subtracting a single bit binary value B from another A (ie $A - B$) produces a difference bit D and a borrow out bits B_{out} . This operation is called half-subtraction and the circuit to realize it is called a half-subtractor. The boolean functions describing half-subtractor are -

$$D = A \oplus B$$

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

Full Subtractor: A combinational circuit which is used to perform sub-traction of three input bits: the minuend, the subtrahend and the other is taking into account borrow of the previous adjacent lower minuend bit. The circuit has two output -

③

The difference and borrow out, The boolean functions -

$$D = A \oplus B \oplus C_i$$

$$\text{Borrow} = \bar{A}B + C(A \oplus B)'$$

① To realize Half-Adder:

Truth Table:

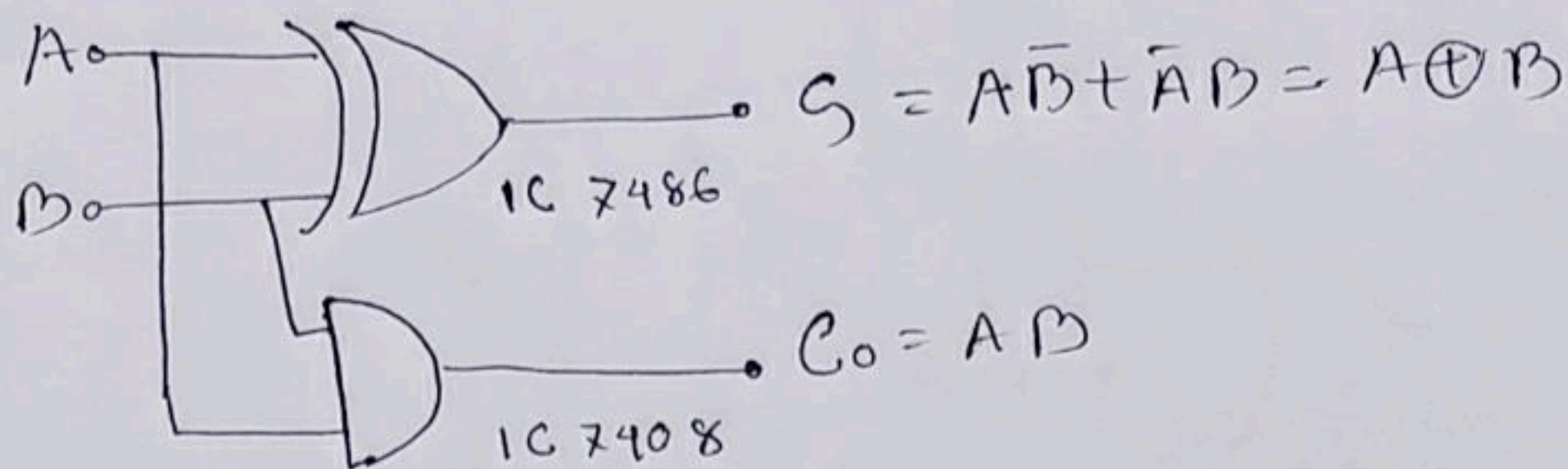
Inputs		Outputs	
A	B	C_o	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Boolean Expression -

$$S = A \oplus B$$

$$C_o = AB$$

Logic Circuit (using basic gates)



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(ii) Full Adder:

Truth Table:

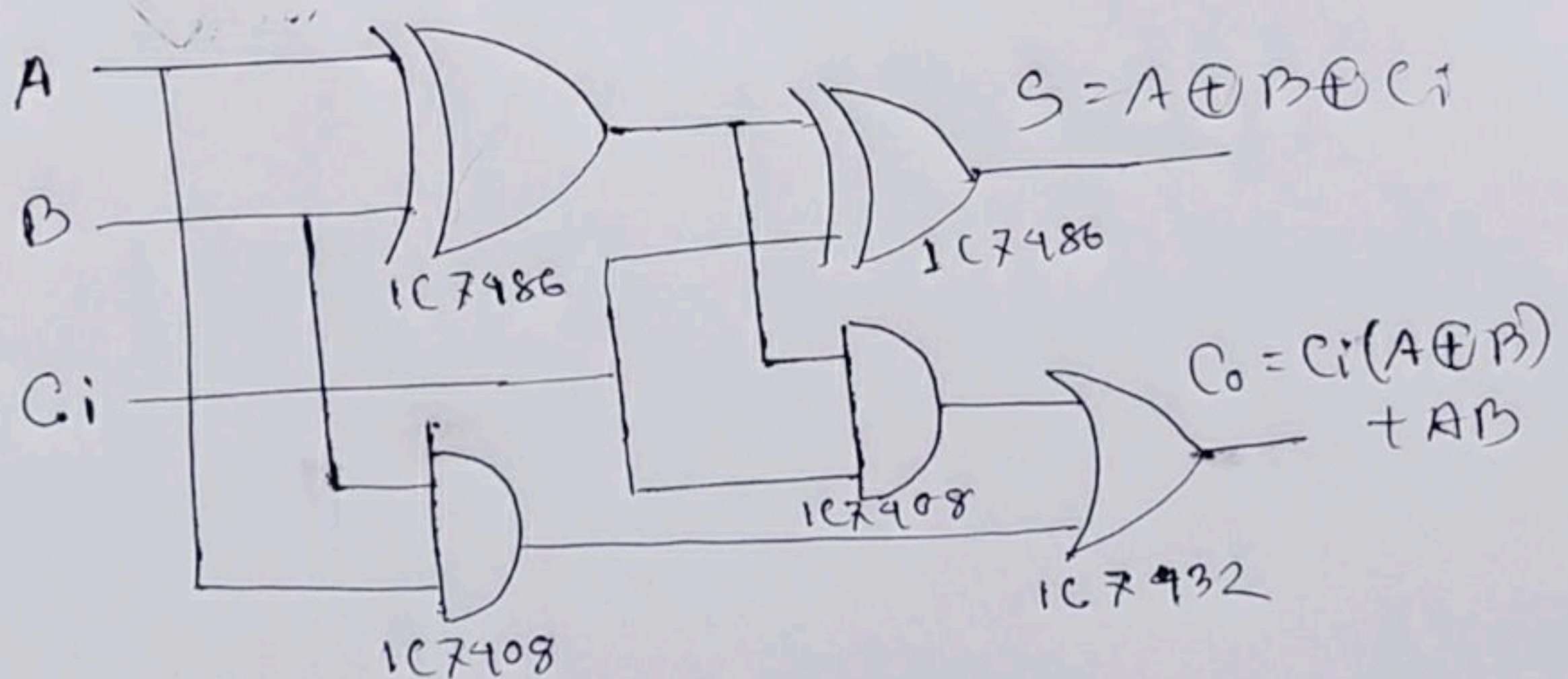
Inputs			Outputs	
A	B	C _i	C _o	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Boolean Expression

$$S = A \oplus B \oplus C_i$$

$$C_o = C_i(A \oplus B) + AB$$

Logic circuit:



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Half-Subtractor:

Truth Table:

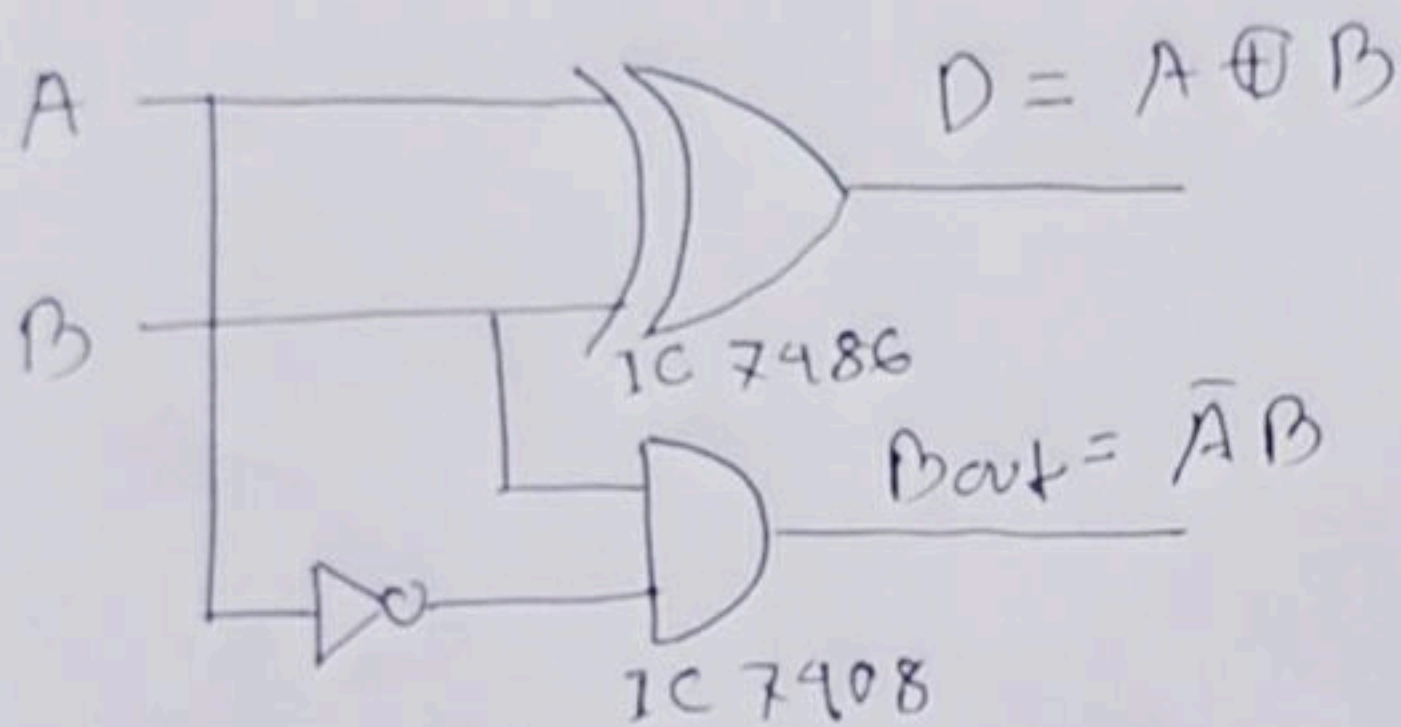
Inputs		Outputs	
A	B	D	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Boolean Expressions:

$$D = A \oplus B$$

$$\text{Borrow} = \bar{A} B$$

Logic Circuits:



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Full Subtractor:

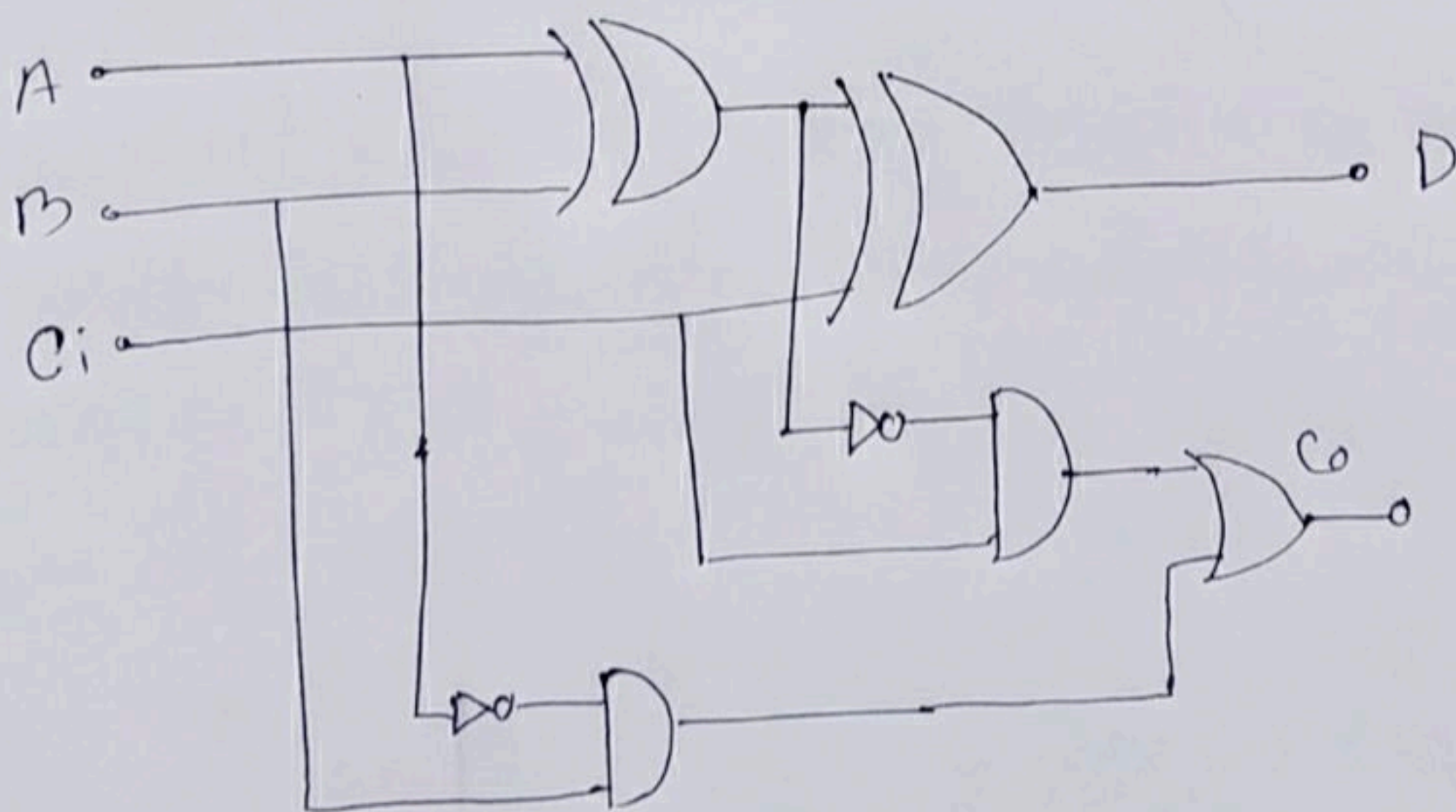
Inputs			Outputs	
A	B	C _i	D	B _{out}
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Boolean Expressions:

$$D = A \oplus B \oplus C_i$$

$$B_{out} = \bar{A}B + C(A \oplus B)'$$

Logic circuit



Procedure:

- ▣ Check the components for their working.
- ▣ Insert the appropriate IC into the IC base.
- ▣ Make connections as shown in the circuit diagram.
- ▣ Verify the truth table and observe the outputs.

Result:

The truth table of the above circuits is verified.

Viva question:

① What is Half-Adder?

Ans: Half adder is a combinational logic circuit that performs the addition of two data bit (A, B) and produces two output bits, Sum and carry bit.

$$S = A \oplus B$$

$$C = AB$$

② What is full Adder?

Ans: Full Adder is a combinational logic circuit that performs addition of two data bits (A, B) & previous stage carry bit (C_i). The Boolean function representing a full Adder are -

$$S = A \oplus B \oplus C_i$$

$$C_o = B C_i + A C_i + A B$$

③ What are the applications of adder?

Ans: To perform a binary bits the Arithmetic and logic unit present in the computer perform this adder circuit. The combination of half Adder & ~~OR~~ ~~AND~~ circuits leads to the formation of the Full Adder circuit.

④ What is half-subtractor?

Ans: The half-subtractor is a combinational circuit which is used to perform subtraction of two bits. It has two input minuend and subtrahend and two outputs the Difference and Borrow out.

⑦ Obtain the minimal expression for above circuits -

Ans)

For half adder:

Sum

A \ B	0	1
0	0	1
1	1	0

$$S = \bar{A}B + A\bar{B}$$

Carry

A \ B	0	1
0	0	0
1	0	1

$$C = AB$$

For Full Adder:

Sum

A \ B C _i	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$$S = A\bar{B}\bar{C}_i + \bar{A}B\bar{C}_i + \bar{A}B C_i + A B C_i$$

Carry

A \ B C _i	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$$C_i = B C_i + A C_i + AB$$

For half subtractor:

Difference D

A \ B	0	1
0	0	1
1	1	0

$$D = A\bar{B} + \bar{A}B$$

Borrow

A \ B	0	1
0	0	1
1	0	0

$$\text{Borrow} = \bar{A}B$$

For Full-subtractor:

Difference

	$B C_i$	00	01	10	11
A					
0		0	1	0	1
1		1	0	1	0

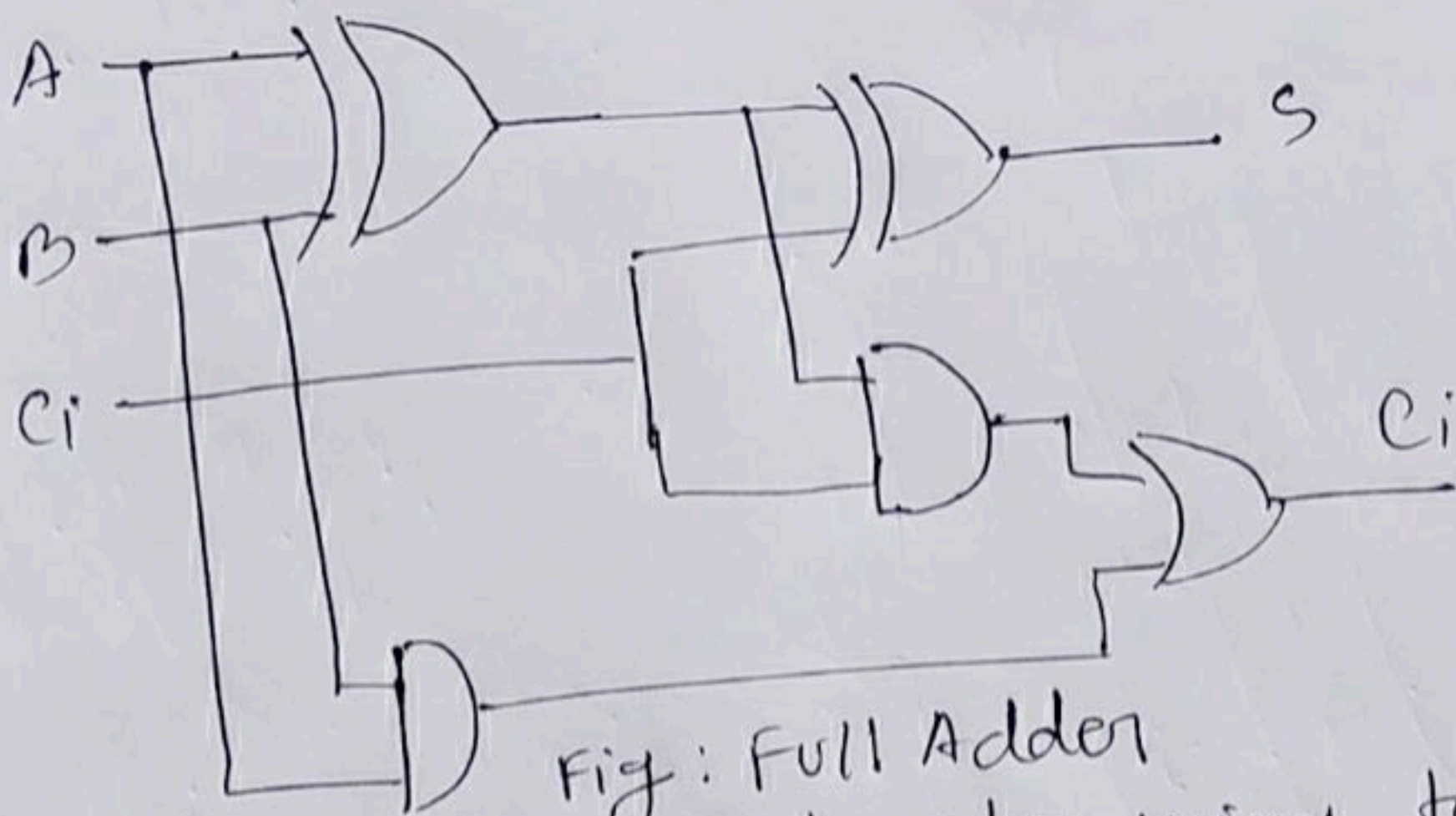
Borrow

	$B C_i$	00	01	11	10
A					
0		0	1	1	1
1		0	0	1	0

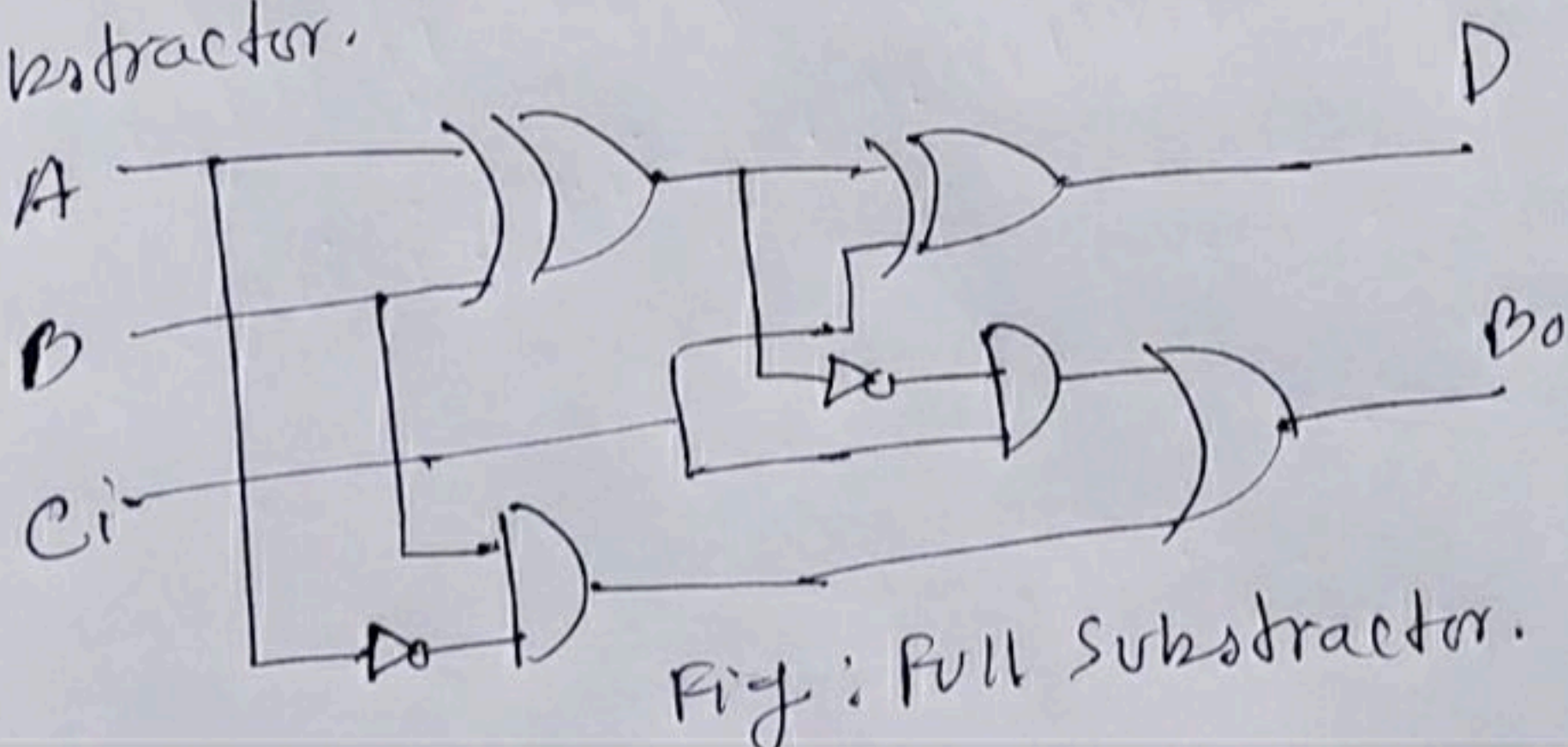
$$D = A\bar{B}\bar{C}_i + \bar{A}B\bar{C}_i + \bar{A}B\bar{C}_i + ABC_i \quad \text{Borrow} = \bar{A}C_i + \bar{A}B + BC_i$$

Q8. Realize a full Adder using two half-adders.

Ans:



Q9. Realize a full subtractor using two half subtractor.



$$D = A \oplus B$$

$$\text{Borrow} = \bar{A}B$$

⑤ What is a full-subtractor?

Ans: A combinational circuit used to perform subtraction of three input bits. The minused, subtrahend and borrow in. It generates two output bits. The difference and borrow out. The boolean function.

$$D = A \oplus B \oplus C_i$$

$$\text{Borrow} = BC + A'C + A'B$$

⑥ What are the application of subtraction?

Ans: Subtractors are mostly used for performing arithmetical function like subtractor, is electronic calculator as well as digital devices. There are generally employed for ALU (arithmetic logic circuit unit) in computers to subtract as CPU & GPU for the applications of graphic to decrease the circuit difficulty.