



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **19ECB231 – DIGITAL ELECTRONICS**

II YEAR/ III SEMESTER

UNIT 2 – COMBINATIONAL CIRCUITS

TOPIC - HALF ADDER ,FULL ADDER,HALF SUBTRACTOR AND FULL SUBTRACTOR



## WHAT IS COMBINATIONAL CIRCUIT?



- Output is function of input only  
i.e. no feedback



Combinational Logic Circuits are memoryless digital logic circuits whose output at any instant in time depends only on the combination of its inputs.



# HALF ADDER



## Half Adder

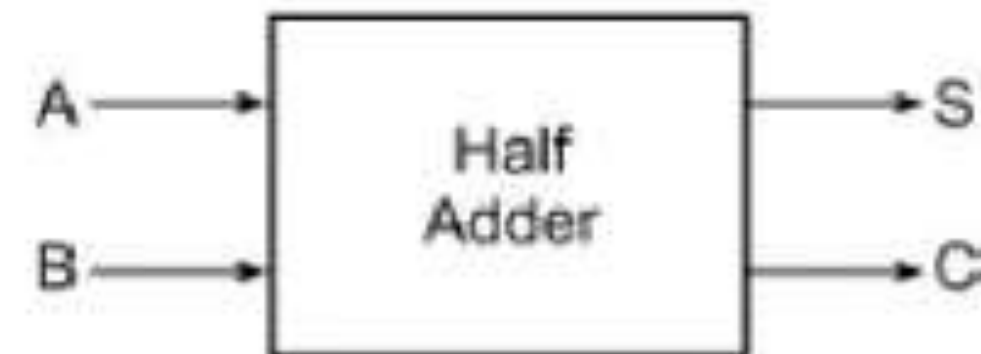
Adds **1-bit** plus **1-bit**

Produces **Sum** and **Carry**

$$\text{SUM } S = A.\bar{B} + \bar{A}.B$$

$$\text{CARRY } C = A.B$$

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1





# HALF ADDER



For Carry

A \ B	0	1
0	0	0
1	0	1

$$\text{Carry} = AB$$

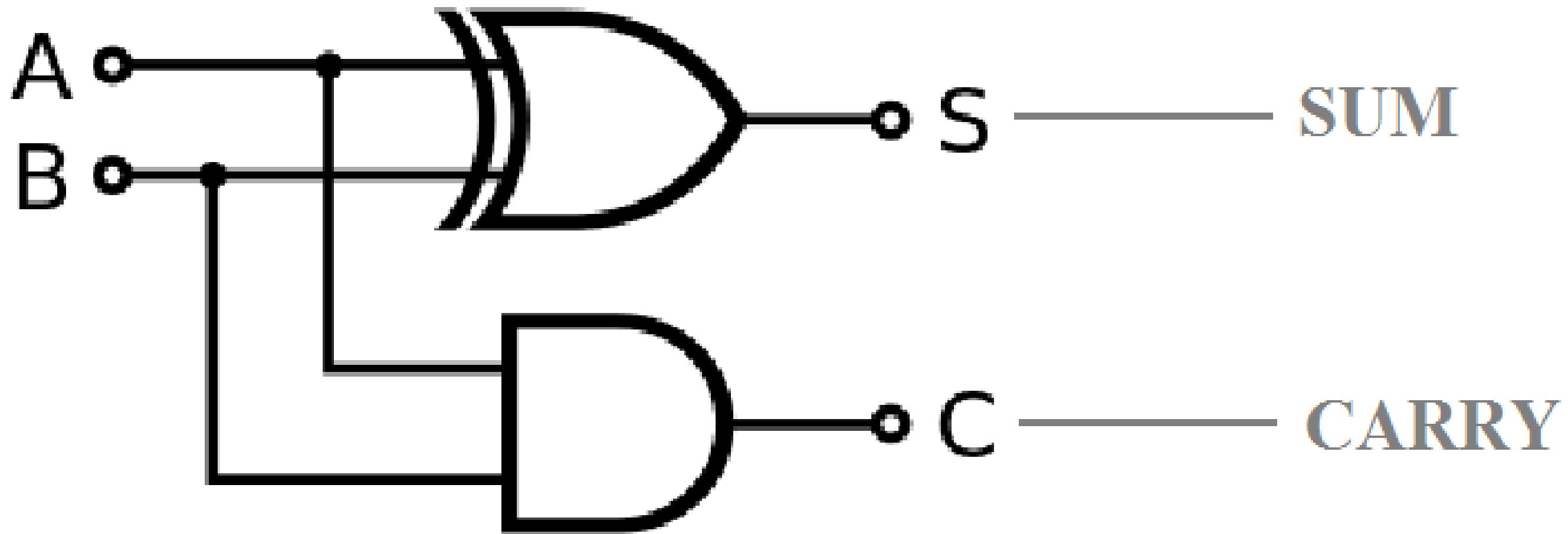
For Sum

A \ B	0	1
0	0	1
1	1	0

$$\begin{aligned}\text{Sum} &= A\bar{B} + \bar{A}B \\ &= A \oplus B\end{aligned}$$

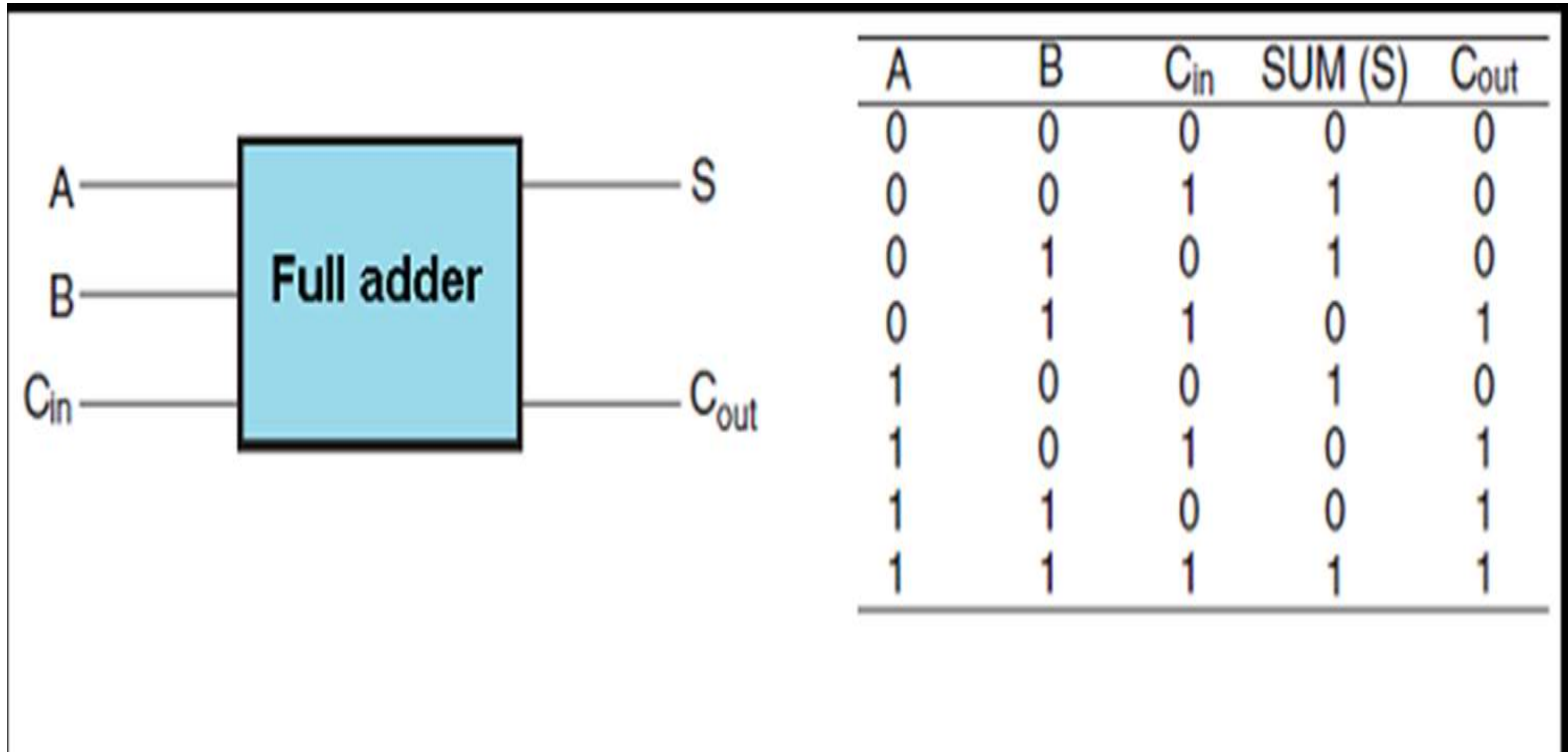


# HALF ADDER





# FULL ADDER





# FULL ADDER

**For Carry ( $C_{out}$ )**

$A \backslash BC_{in}$	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$$C_{out} = AB + AC_{in} + BC_{in}$$

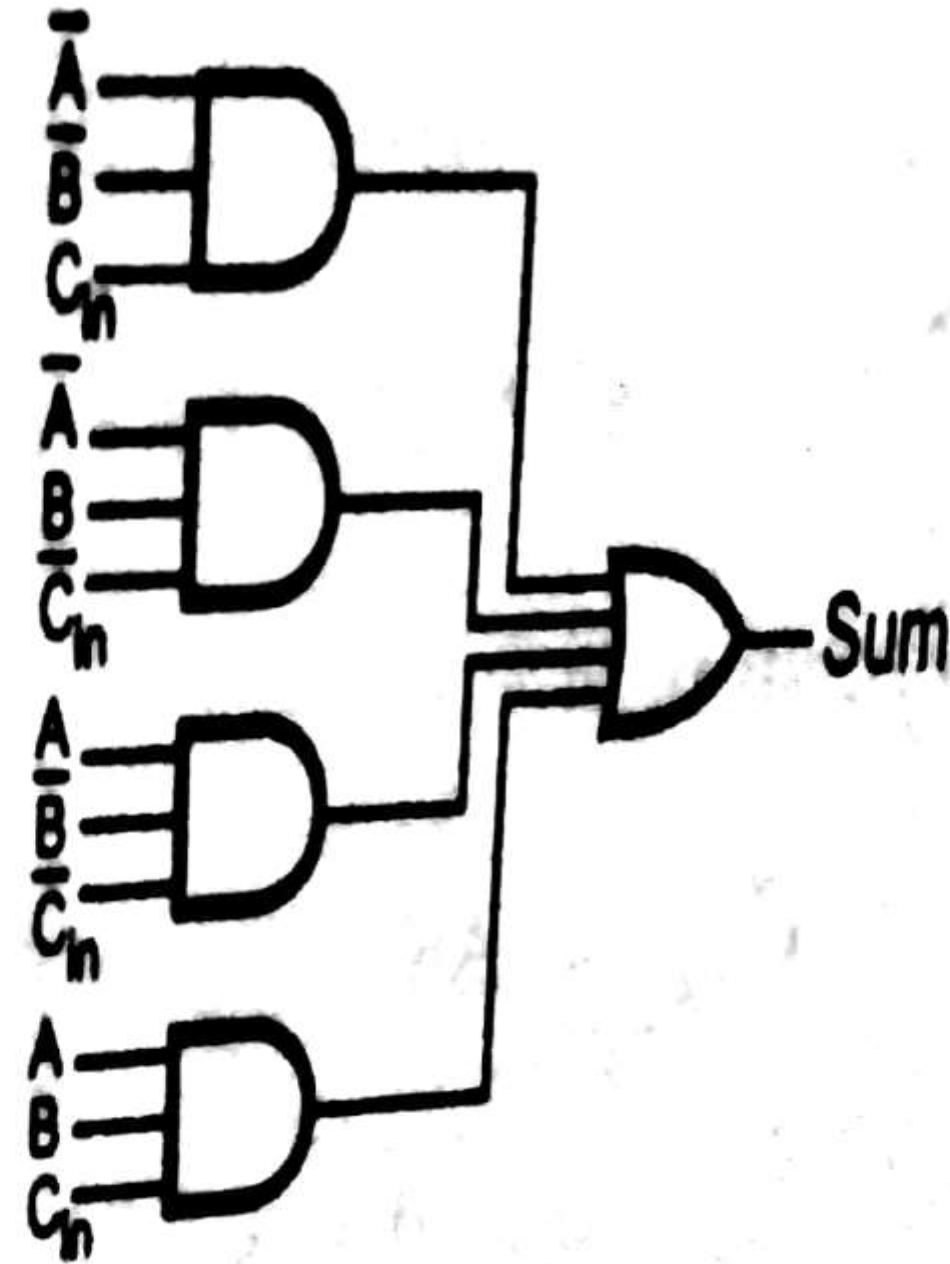
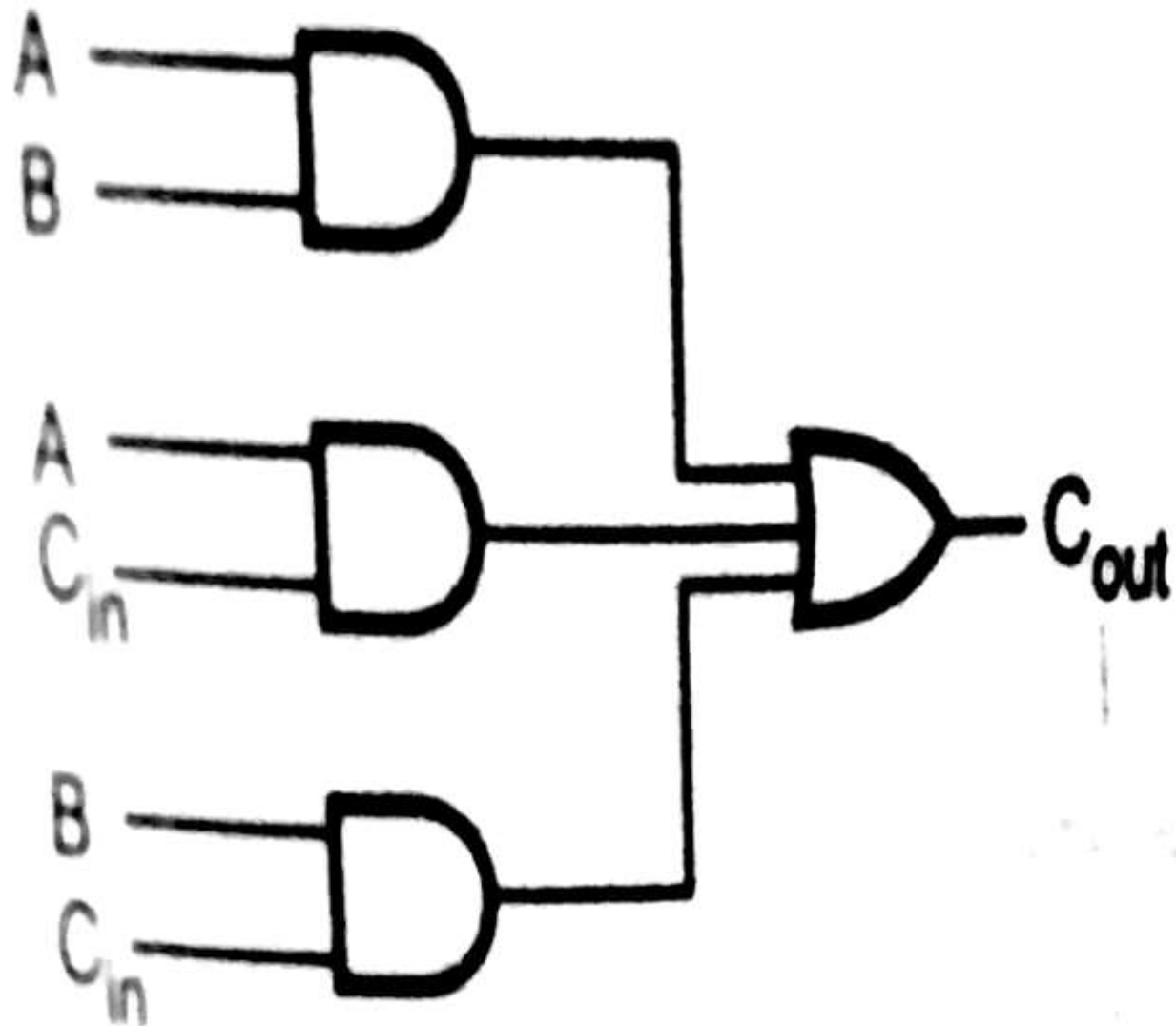
**For Sum**

$A \backslash BC_{in}$	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$



# LOGICAL DIAGRAM





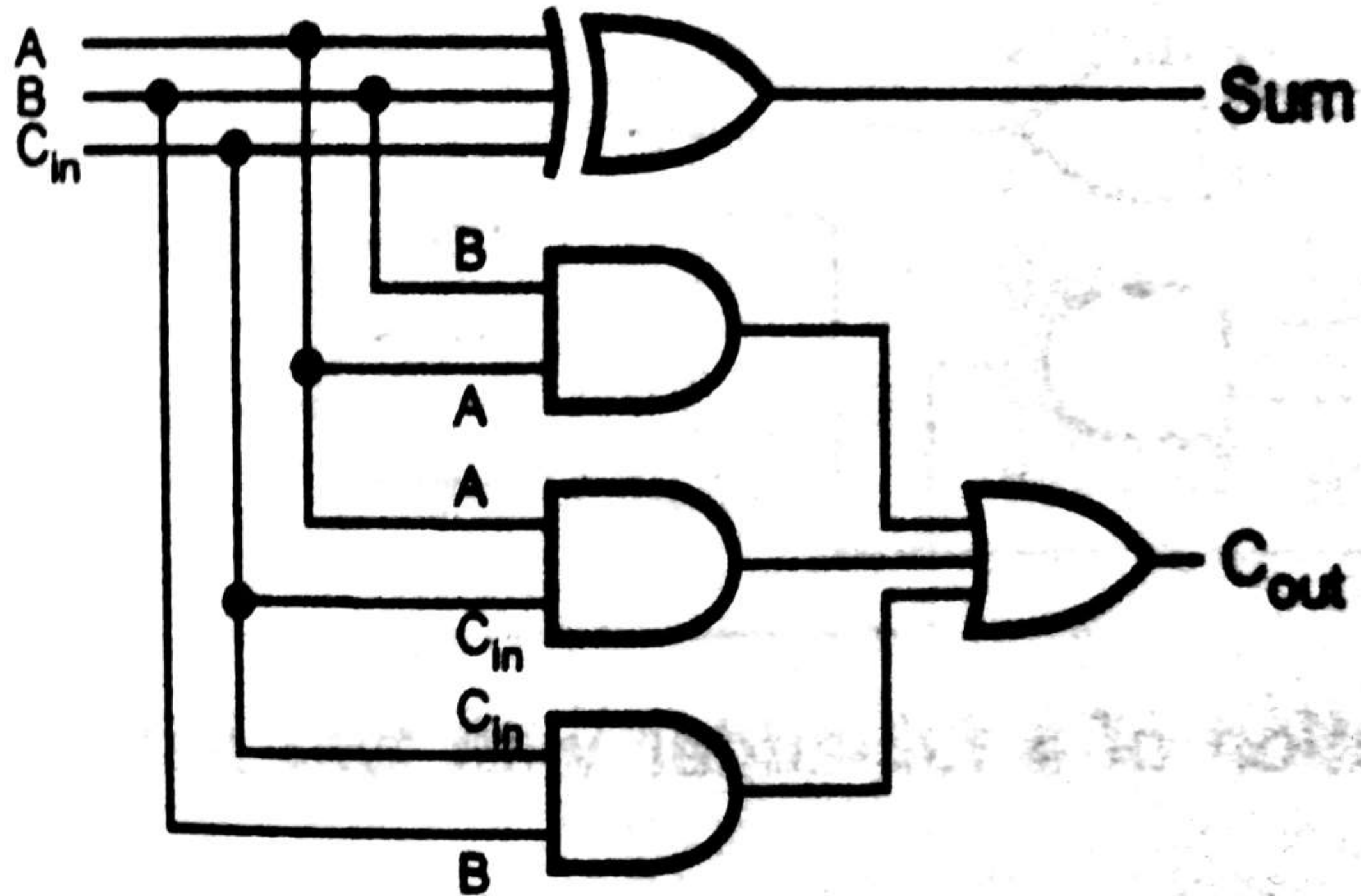


## FULL ADDER

$$\begin{aligned}\text{Sum} &= \bar{A} \bar{B} C_{in} + \bar{A} B \bar{C}_{in} + A \bar{B} \bar{C}_{in} + ABC_{in} \\ &= C_{in} (\bar{A} \bar{B} + AB) + \bar{C}_{in} (\bar{A} B + A \bar{B}) \\ &= C_{in} (A \cdot B) + \bar{C}_{in} (A \oplus B) \\ &= C_{in} (\overline{A \oplus B}) + \bar{C}_{in} (A \oplus B) \\ &= C_{in} \oplus (A \oplus B)\end{aligned}$$

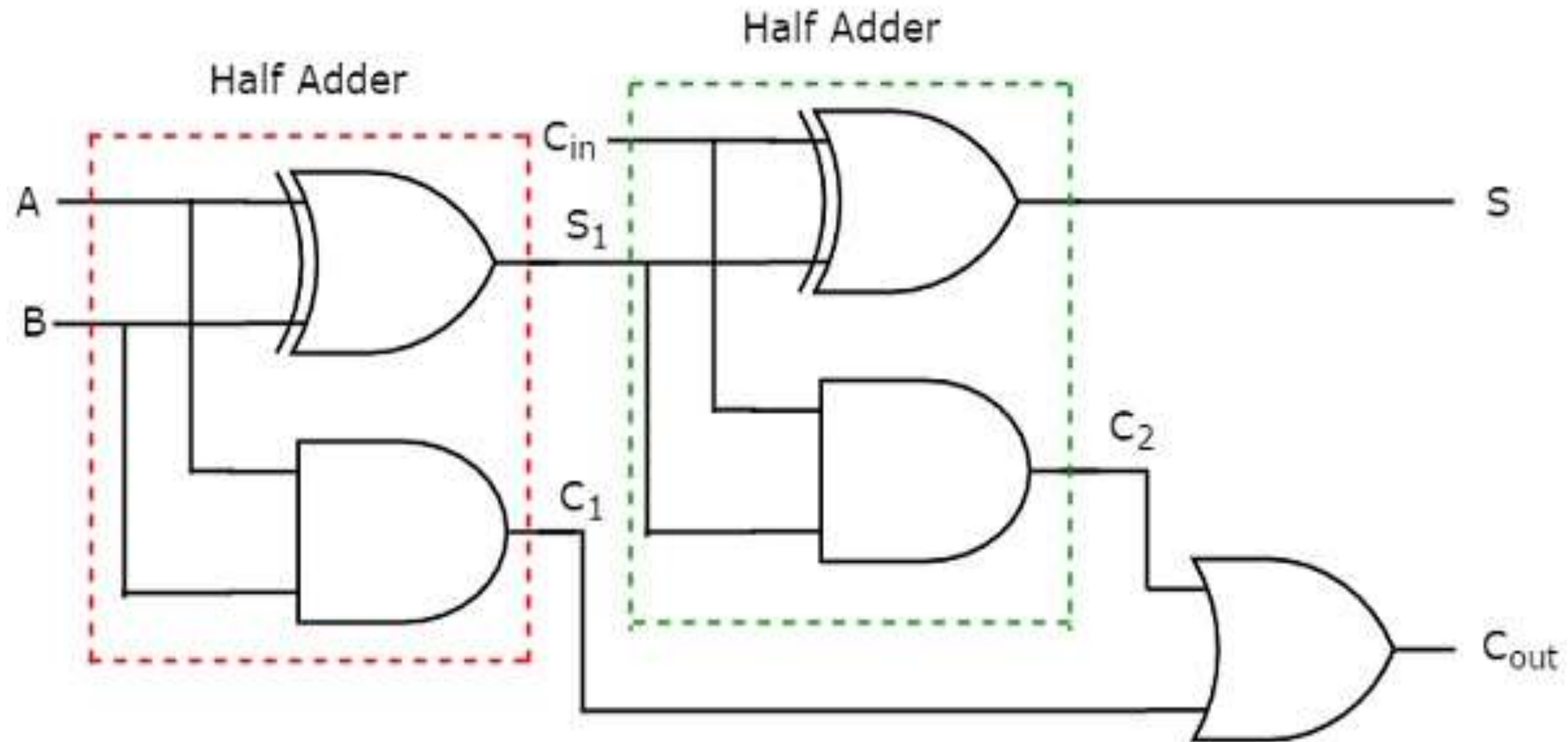


# LOGICAL DIAGRAM





# IMPLEMENTATION OF FULL ADDER USING TWO HALF ADDERS





# HALF SUBTRACTOR



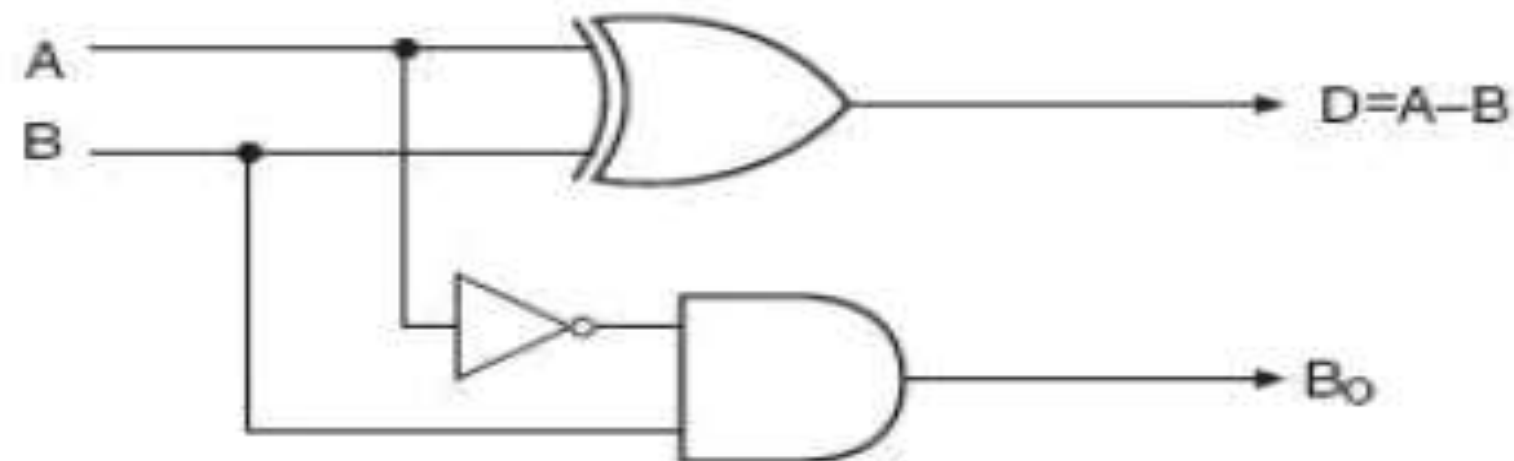
$$D = \bar{A}.B + A.\bar{B}$$

$$B_0 = \bar{A}.B$$



A	B	D	B <sub>0</sub>
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

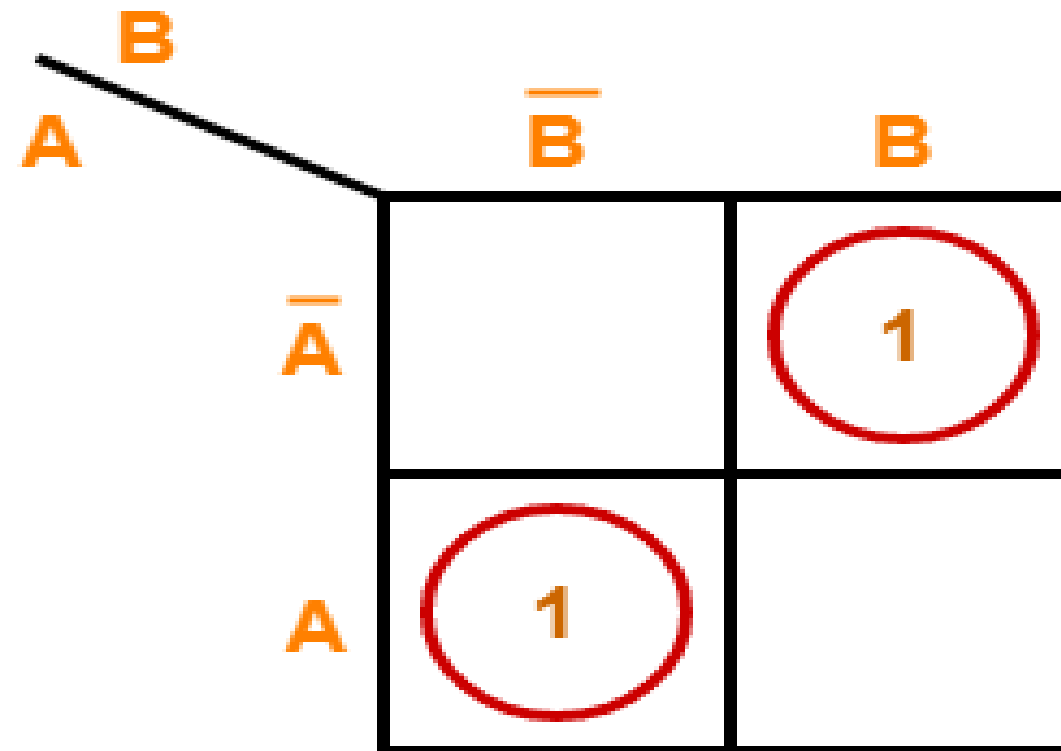
## Half Subtractor





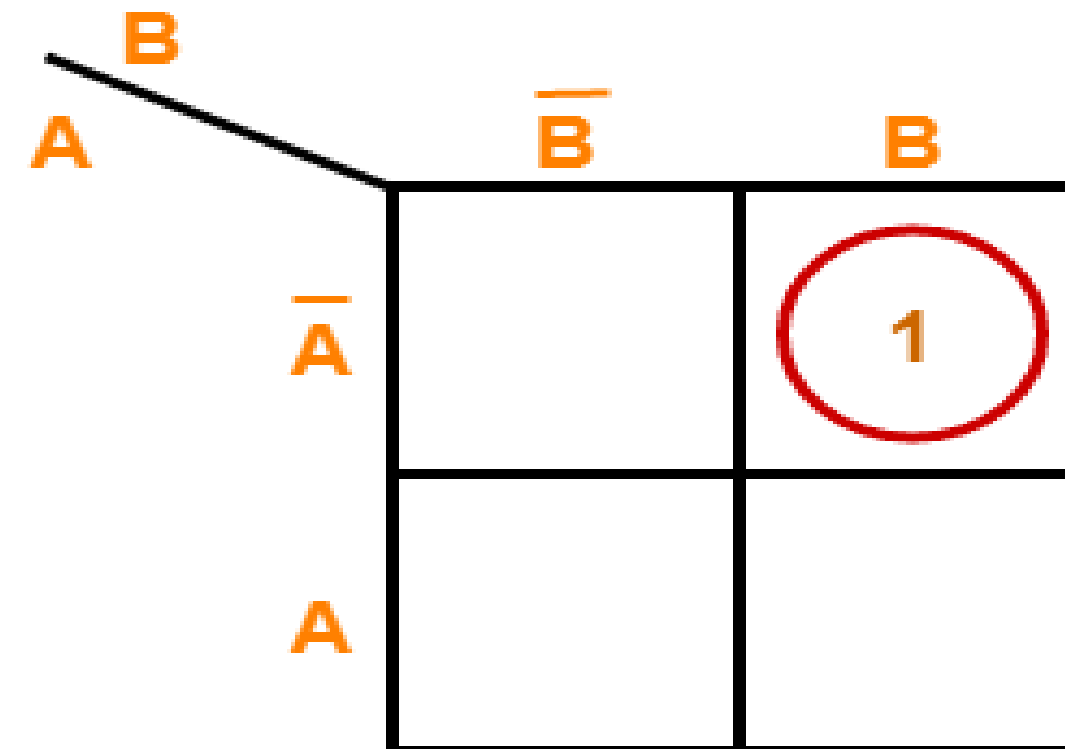
# HALF SUBTRACTOR

For D:



$$D = A \oplus B$$

For b:

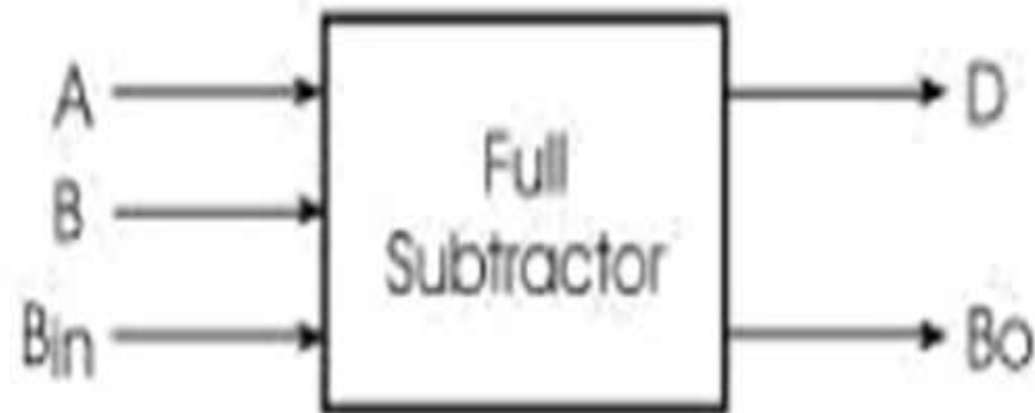


$$b = \bar{A}.B$$

K Maps



# FULL SUBTRACTOR



Minuend (A)	Subtrahend (B)	Borrow In ( $B_{in}$ )	Difference (D)	Borrow Out ( $B_o$ )
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



# FULL SUBTRACTOR



For Difference :-

A \ B	$B B_{in}$ 00	$\bar{B} B_{in}$ 01	$B \bar{B}_{in}$ 11	$\bar{B} \bar{B}_{in}$ 10
$\bar{A}$ 0		1		1
A 1	1		1	

$$\therefore \text{Difference} = A \oplus B \oplus B_{in}$$

$$\begin{aligned} \therefore \text{Difference} &= \bar{A} \bar{B} B_{in} + \bar{A} B \bar{B}_{in} + A \bar{B} \bar{B}_{in} + A B B_{in} \\ &= \bar{A} (\bar{B} B_{in} + B \bar{B}_{in}) + A (\bar{B} \bar{B}_{in} + B B_{in}) \\ &= \bar{A} (B \oplus B_{in}) + A (B \odot B_{in}) = \bar{A} (B \oplus B_{in}) + A (\overline{B \oplus B_{in}}) \\ &= A \oplus B \oplus B_{in} = A \oplus B \oplus B_{in}. \end{aligned}$$

For  $B_{out}$  :-

A \ B	$B B_{in}$ 00	$\bar{B} B_{in}$ 01	$B \bar{B}_{in}$ 11	$\bar{B} \bar{B}_{in}$ 10
$\bar{A}$ 0		1	1	1
A 1			1	

$$\therefore B_{out} = \bar{A} B + \bar{A} B_{in} + B B_{in}$$

$$\therefore B_{out} = \bar{A} B + \bar{A} B_{in} + B B_{in}$$



# FULL SUBTRACTOR

For D:

	$BB_{in}$	$\bar{B}\bar{B}_{in}$	$\bar{B}B_{in}$	$BB_{in}$	$B\bar{B}_{in}$
$\bar{A}$		1			1
A	1		1		

$$D = A \oplus B \oplus B_{in}$$

For  $B_{out}$ :

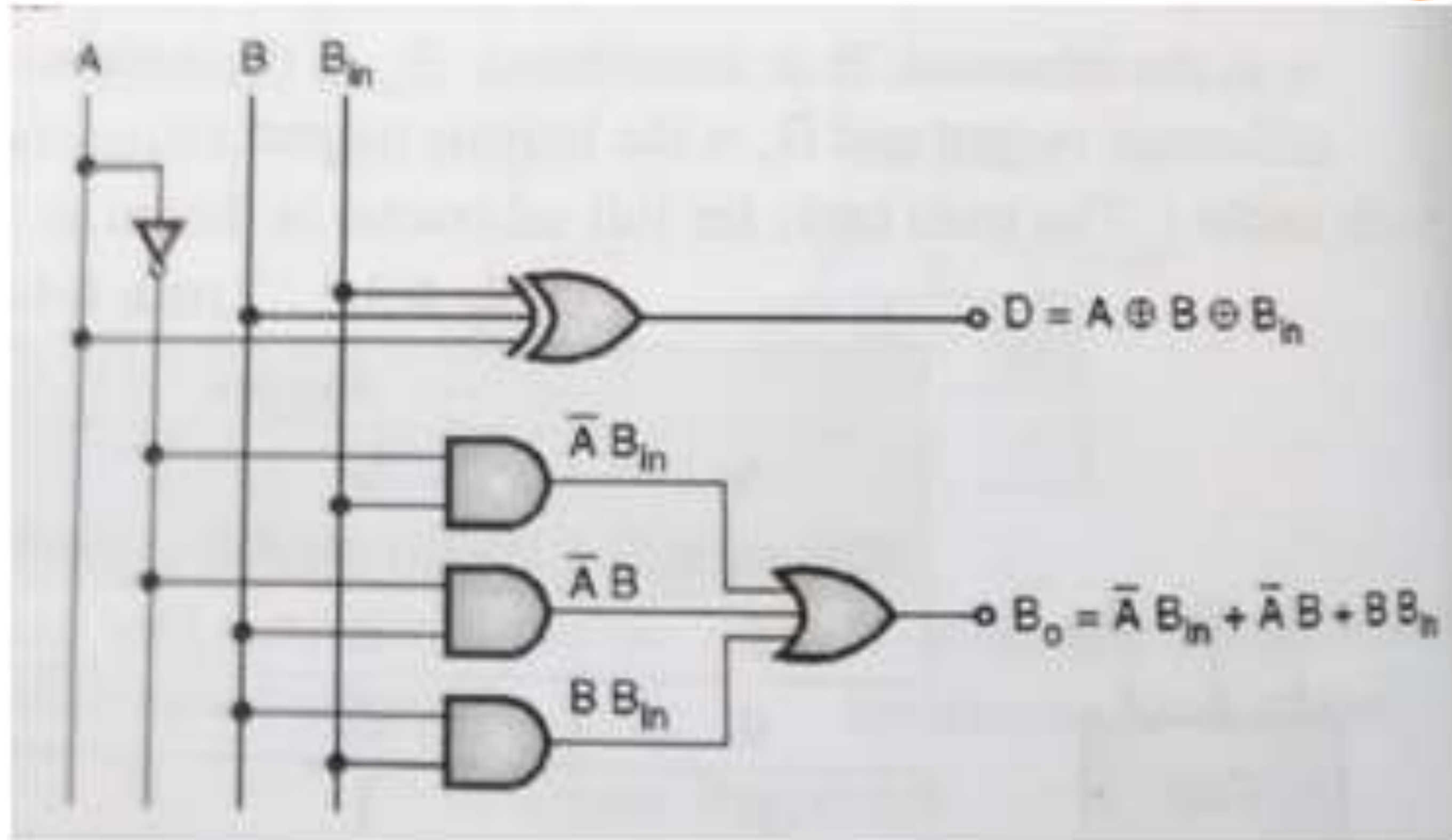
	$BB_{in}$	$\bar{B}\bar{B}_{in}$	$\bar{B}B_{in}$	$BB_{in}$	$B\bar{B}_{in}$
$\bar{A}$			1	1	1
A				1	

$$B_{out} = \bar{A}B + (\bar{A} + B)B_{in}$$



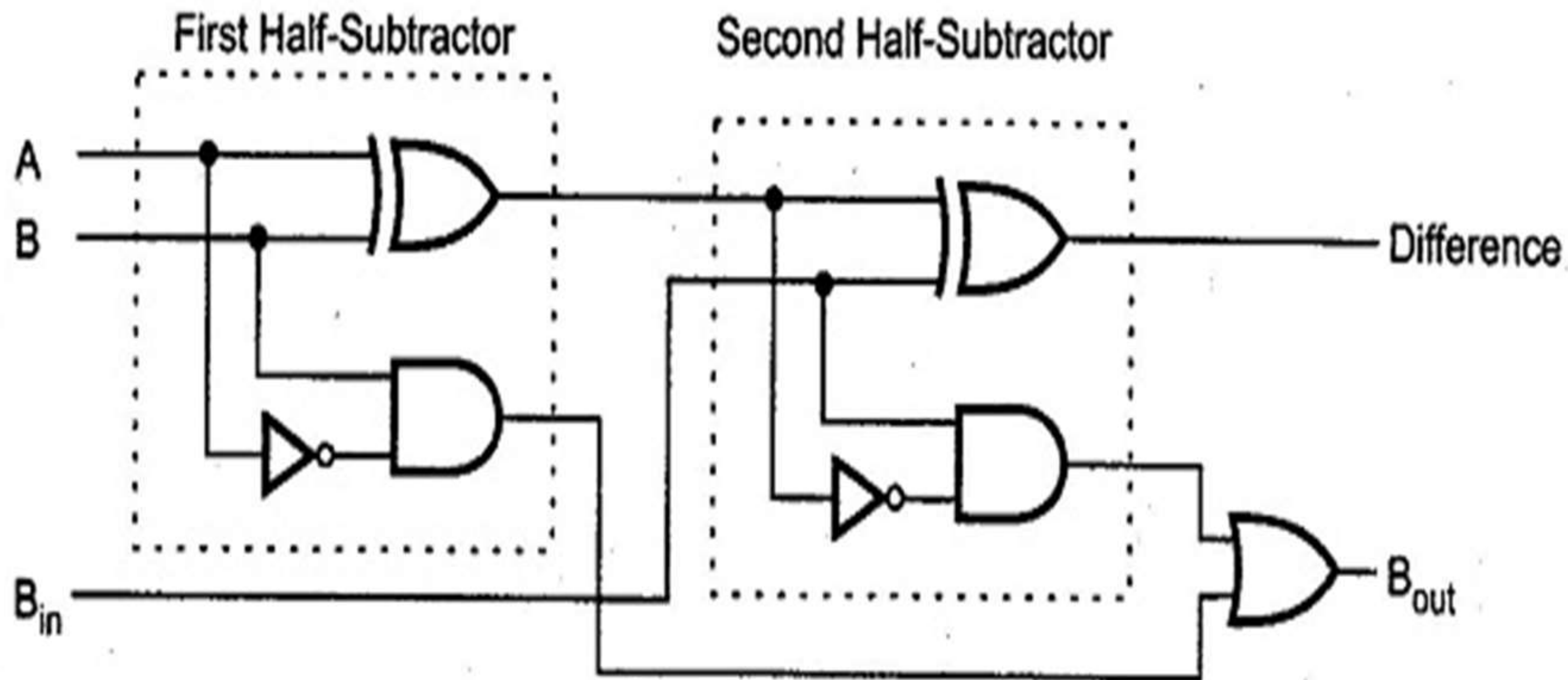


# FULL SUBTRACTOR



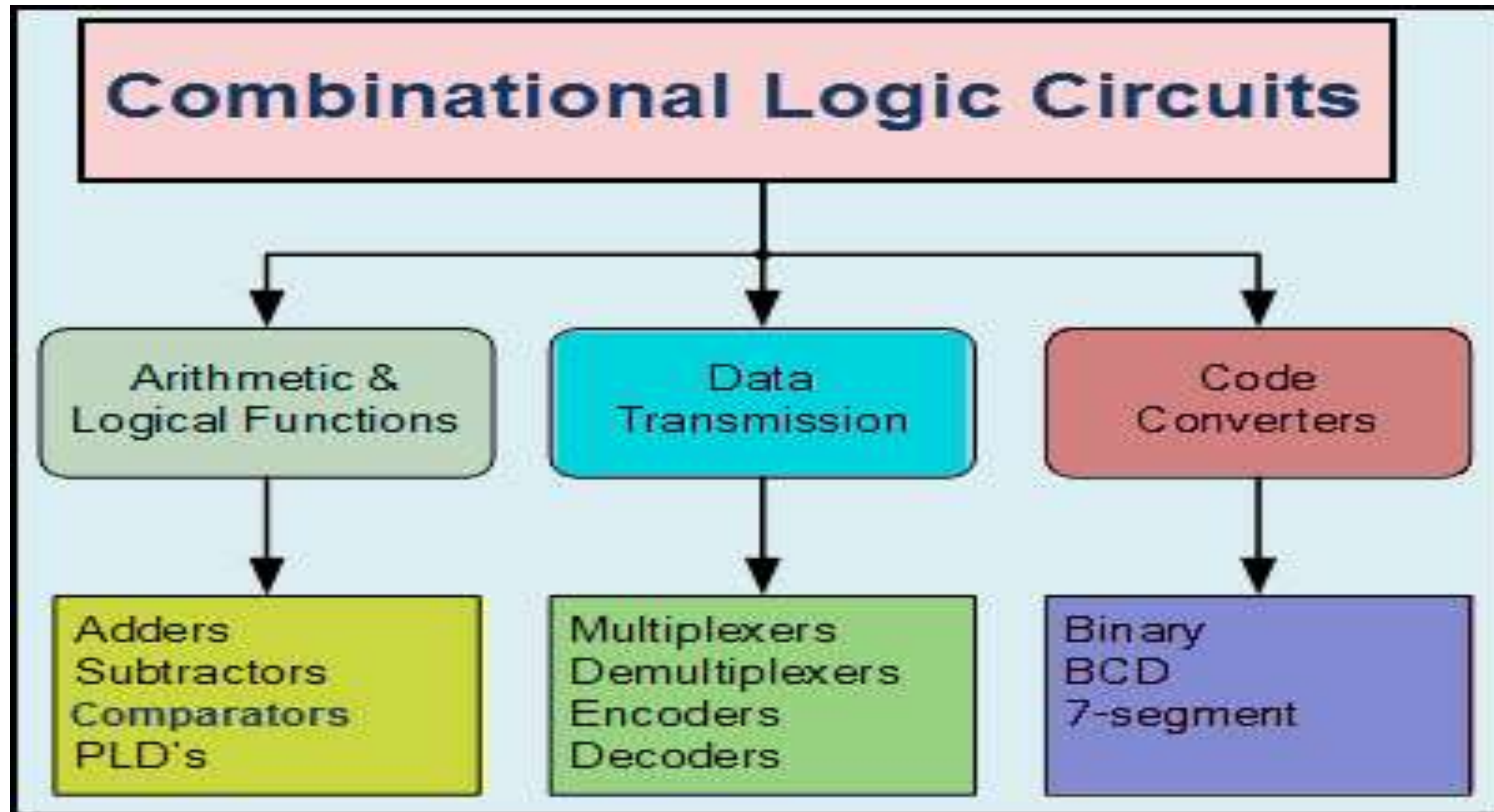


# IMPLEMENTATION OF FULL SUBTRACTOR USING TWO HALF SUBTRACTORS





# APPLICATIONS OF COMBINATIONAL CIRCUITS





## ASSESSMENTS



1. Draw the block diagram of Half adder and Half subtractor.
2. Draw the logical diagram of Full adder.
3. What is Full subtractor?
4. Difference between Full adder and Half adder.



**THANK YOU**