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 1 - 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

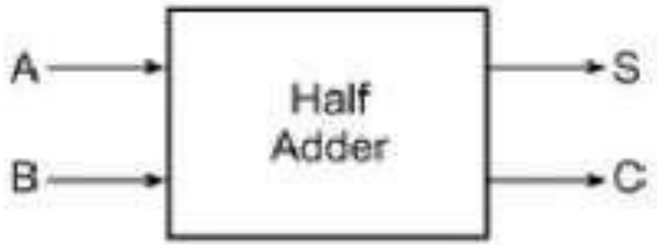
Adds 1-bit plus 1-bit

Produces Sum and Carry

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

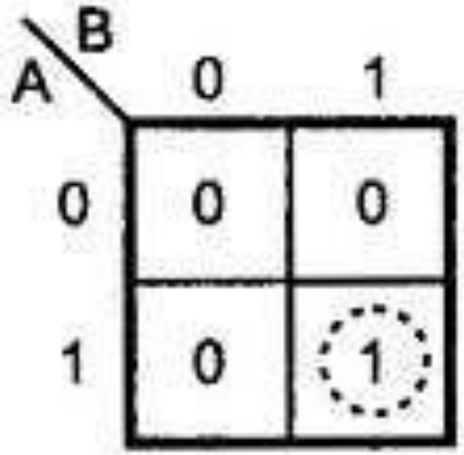
$$\text{CARRY } C = A.B$$

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



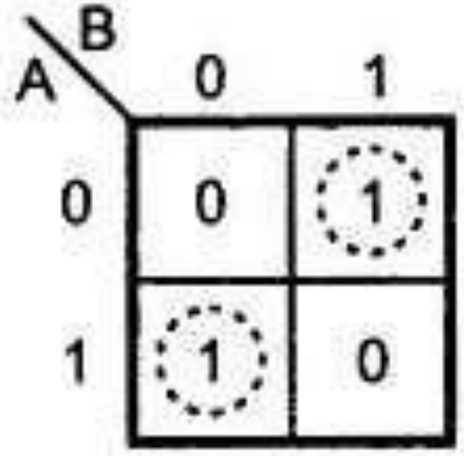
HALF ADDER

For Carry



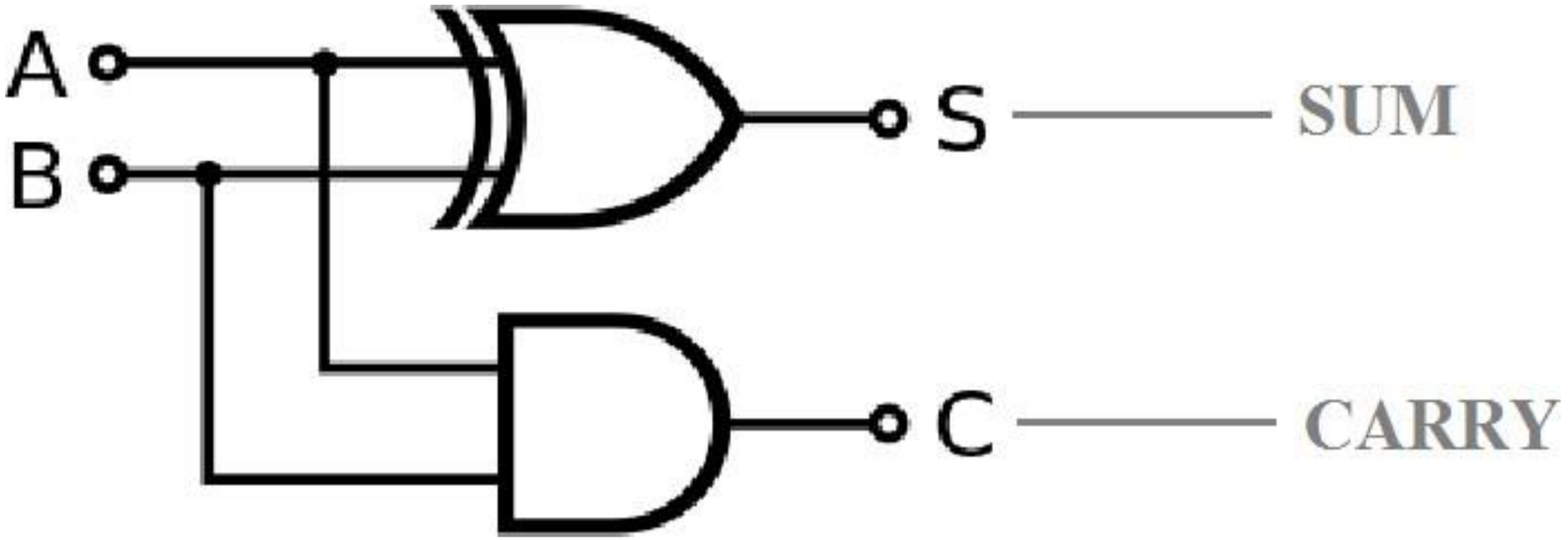
Carry = AB

For Sum



$$\text{Sum} = A\overline{B} + \overline{A}B$$
$$= A \oplus B$$

HALF ADDER

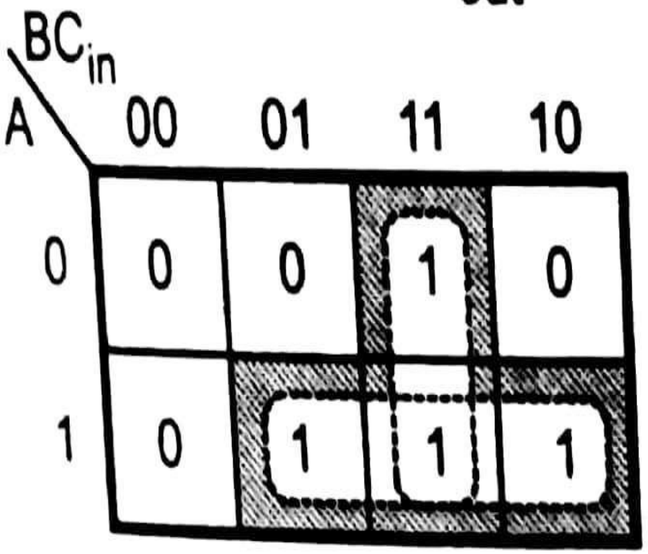


FULL ADDER

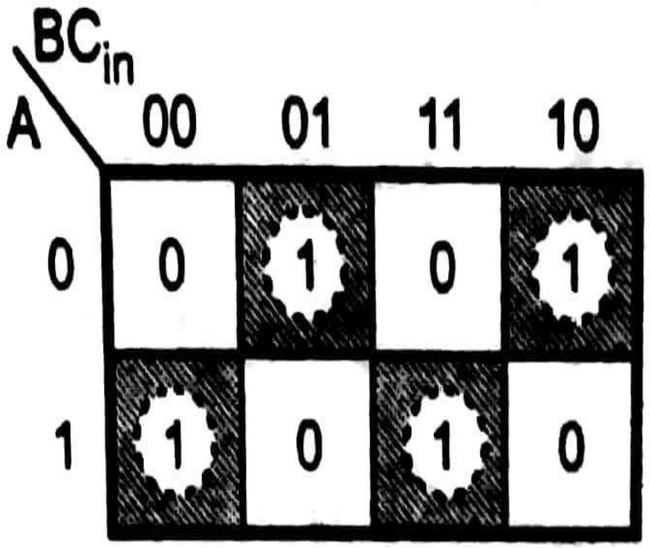
A	B	C_{in}	SUM (S)	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

FULL ADDER

For Carry (C_{out})



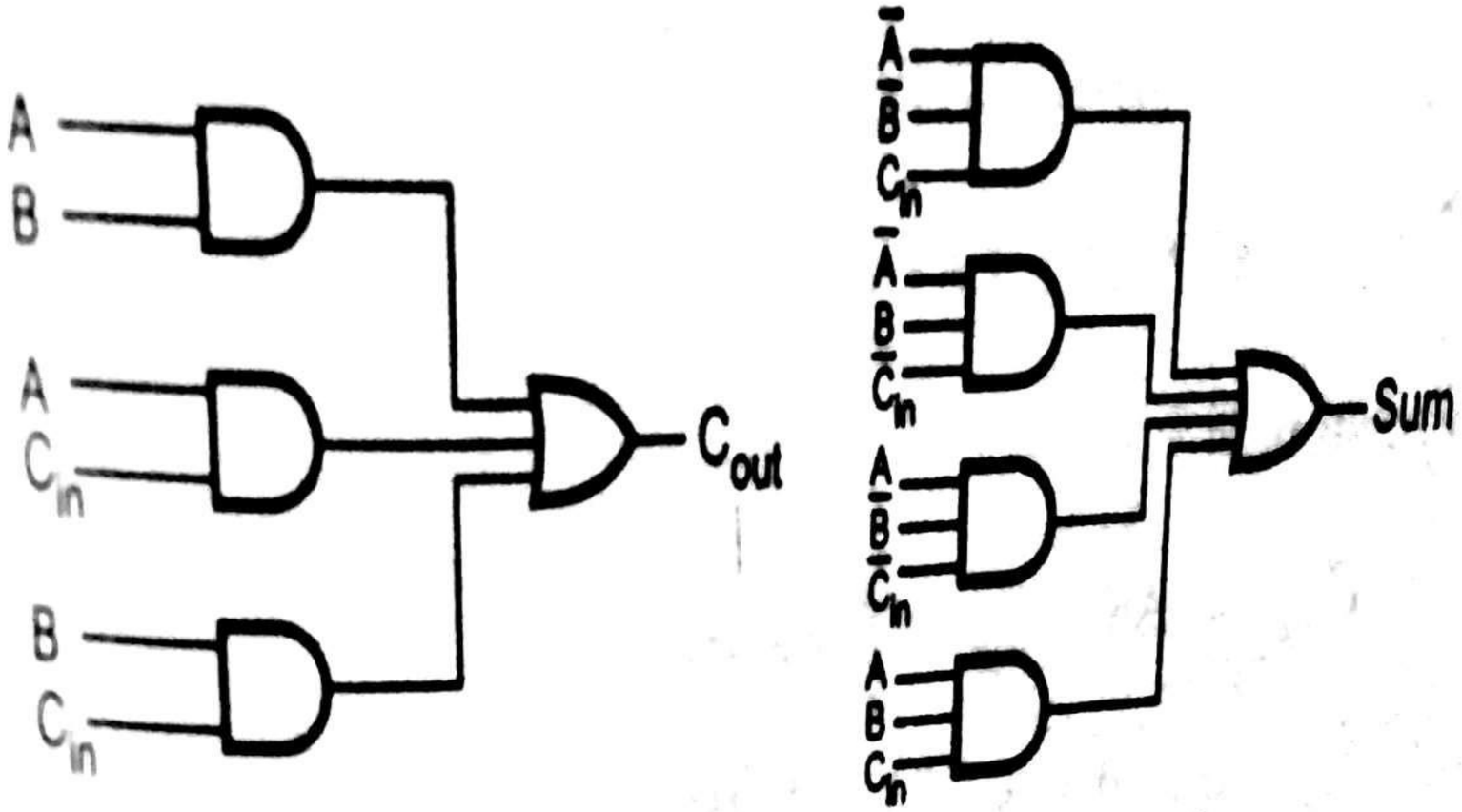
For Sum



$$C_{out} = AB + A C_{in} + B C_{in}$$

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

LOGICAL DIAGRAM



FULL ADDER

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

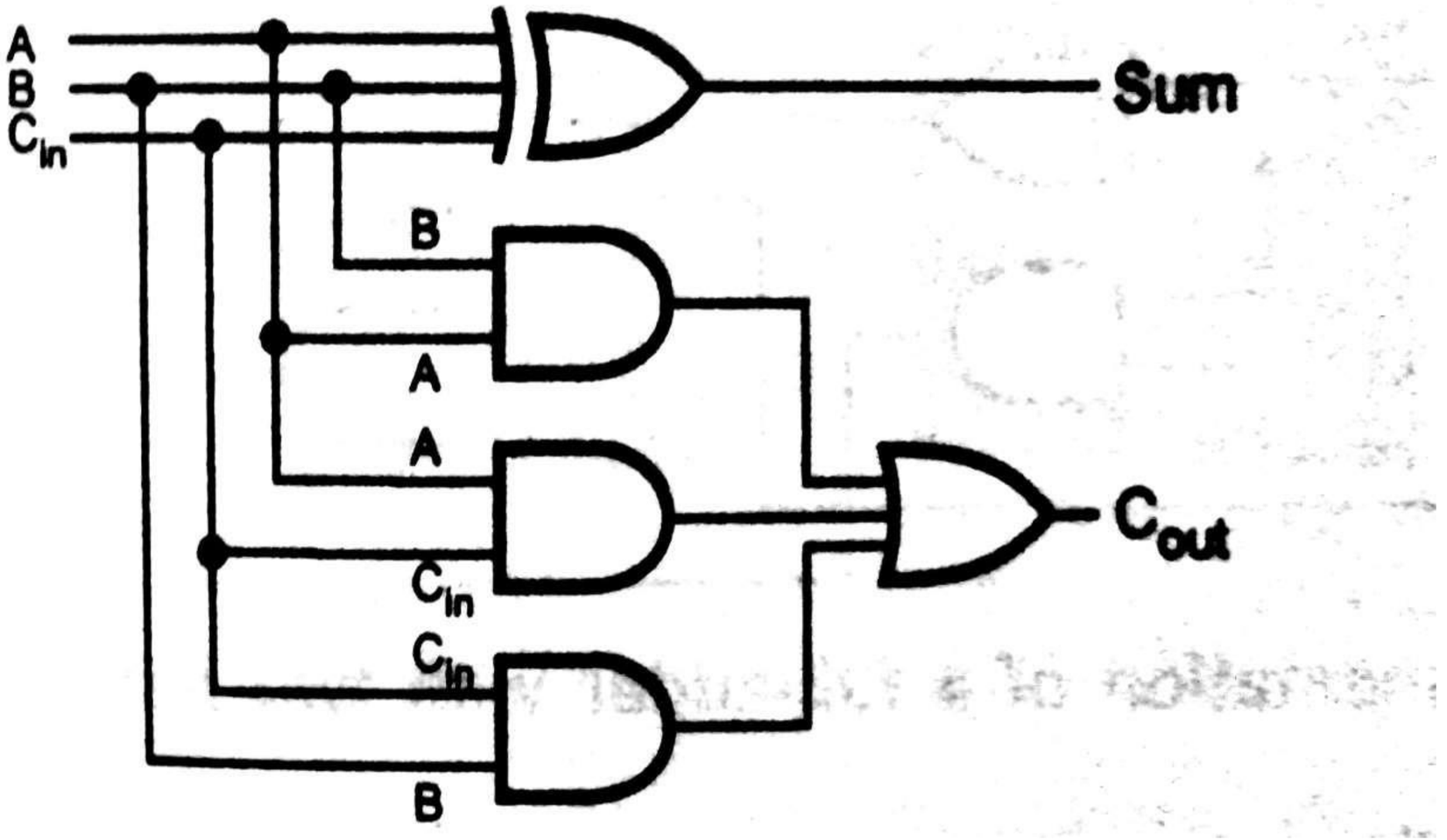
$$= C_{in}\,(\bar{A}\,\bar{B} + AB) + \bar{C}_{in}\,(\bar{A}\,B + A\,\bar{B})$$

$$= C_{in}\,(A \cdot B) + \bar{C}_{in}\,(A \oplus B)$$

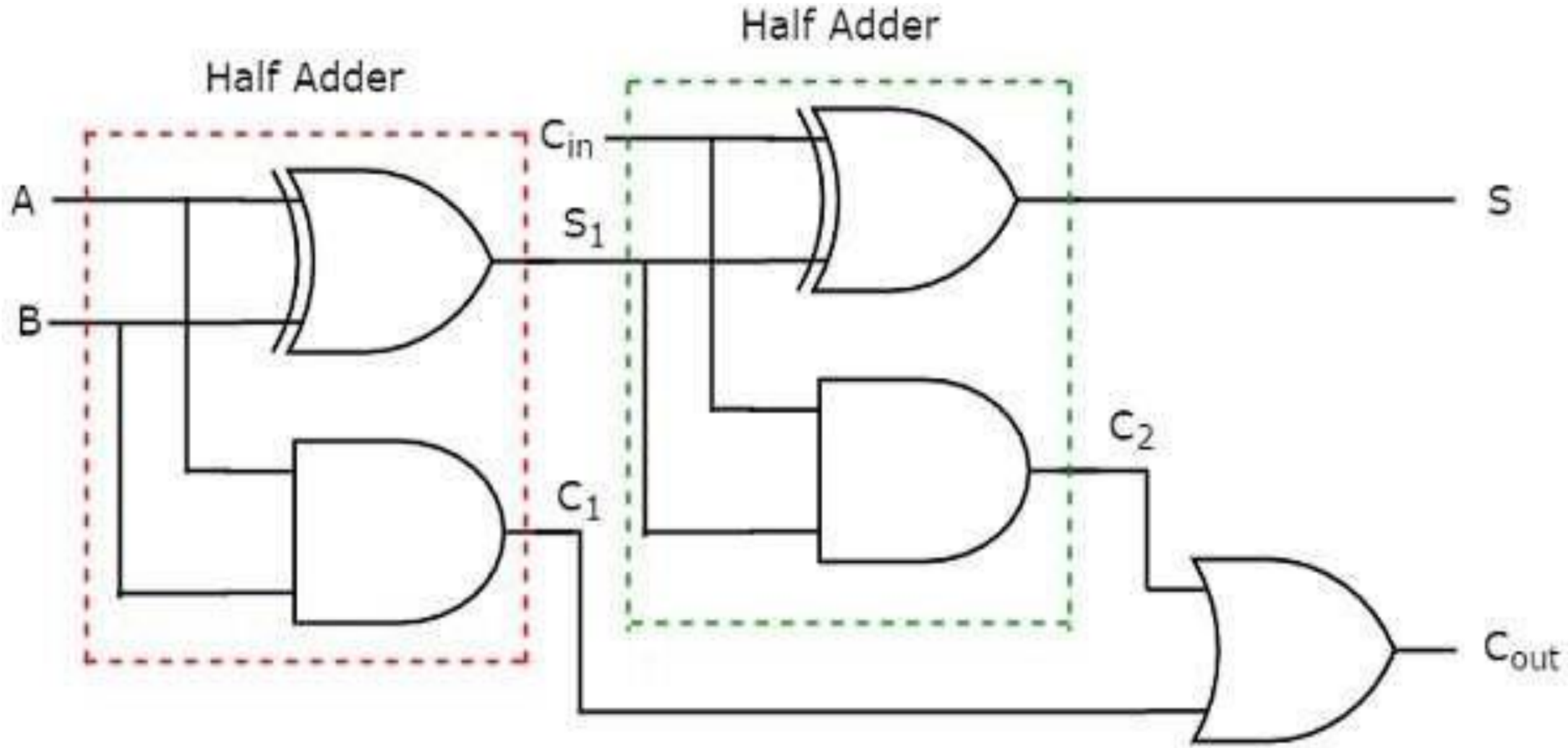
$$= C_{in}\,(\overline{A \oplus B}) + \bar{C}_{in}\,(A \oplus B)$$

$$= C_{in} \oplus (A \oplus B)$$

LOGICAL DIAGRAM



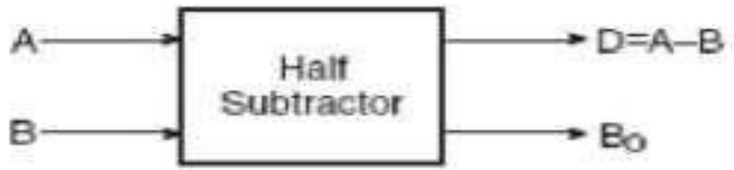
IMPLEMENTATION OF FULL ADDER USING TWO HALF ADDERS



HALF SUBTRACTOR

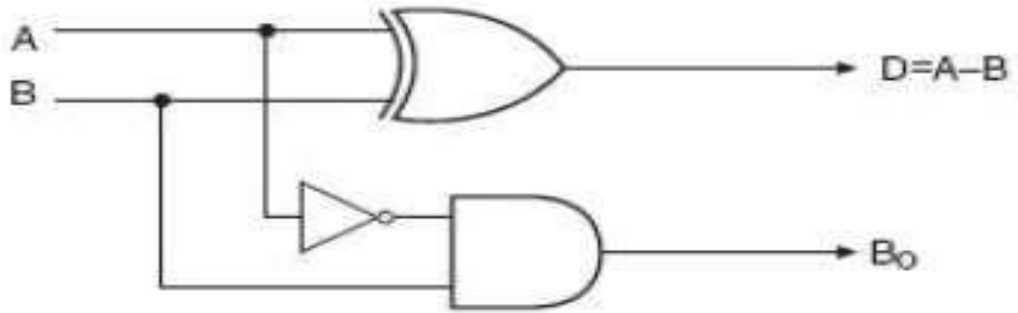
$$D = \overline{A}.B + A.\overline{B}$$

$$B_o = \overline{A}.B$$



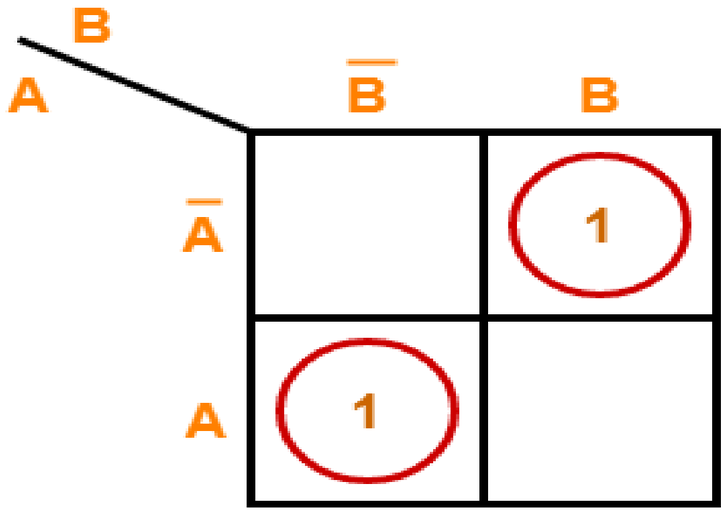
A	B	D	B_O
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Half Subtractor



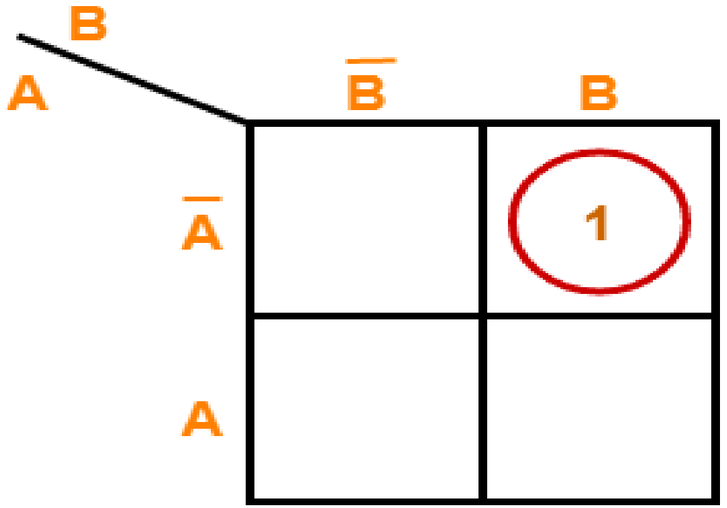
HALF SUBTRACTOR

For D:



$D = A \oplus B$

For b:



$b = \overline{A}.B$

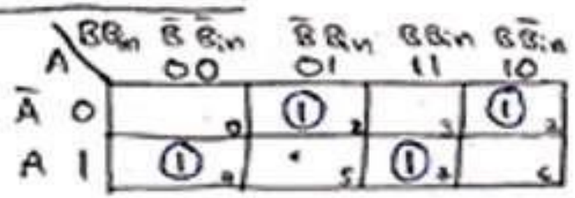
K Maps

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 :-



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

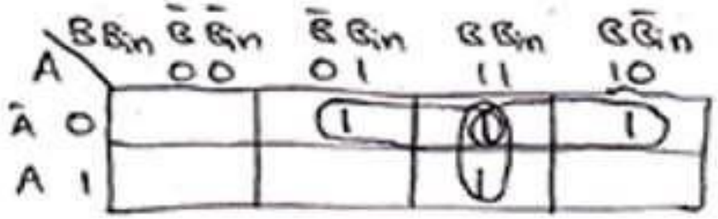
$\therefore$ Difference = $\bar{A}\bar{B}B_{in} + \bar{A}B\bar{B}_{in} + AB\bar{B}_{in} + ABB_{in}$

$= \bar{A}(\bar{B}B_{in} + B\bar{B}_{in}) + A(\bar{B}\cdot\bar{B}_{in} + BB_{in})$

$= \bar{A}(B \oplus B_{in}) + A(B \odot B_{in}) = \bar{A}(B \oplus B_{in}) + A(\overline{B \oplus B_{in}})$

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

For B_{out} :-

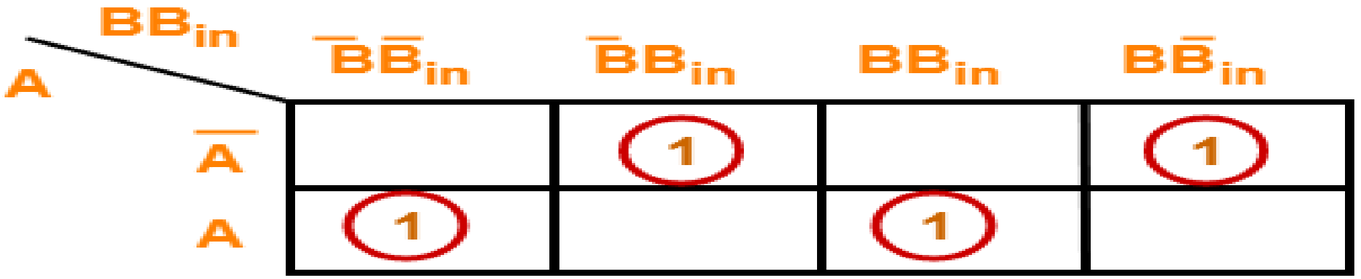


$\therefore$ $B_{out} = \bar{A}B + \bar{A}B_{in} + BB_{in}$

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

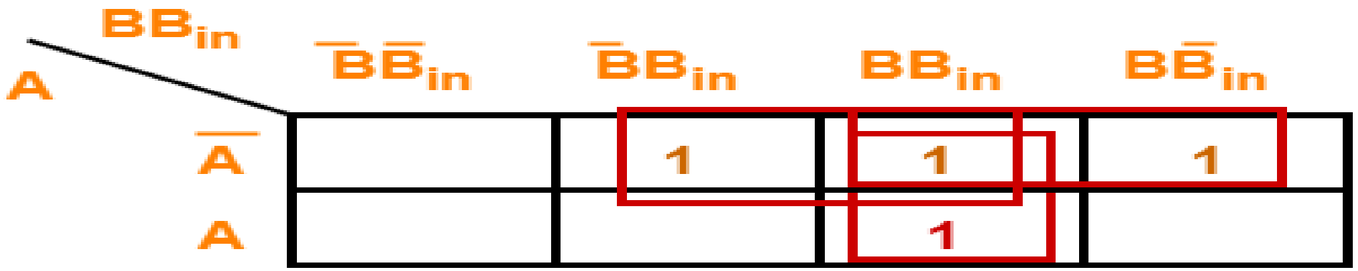
FULL SUBTRACTOR

For D:



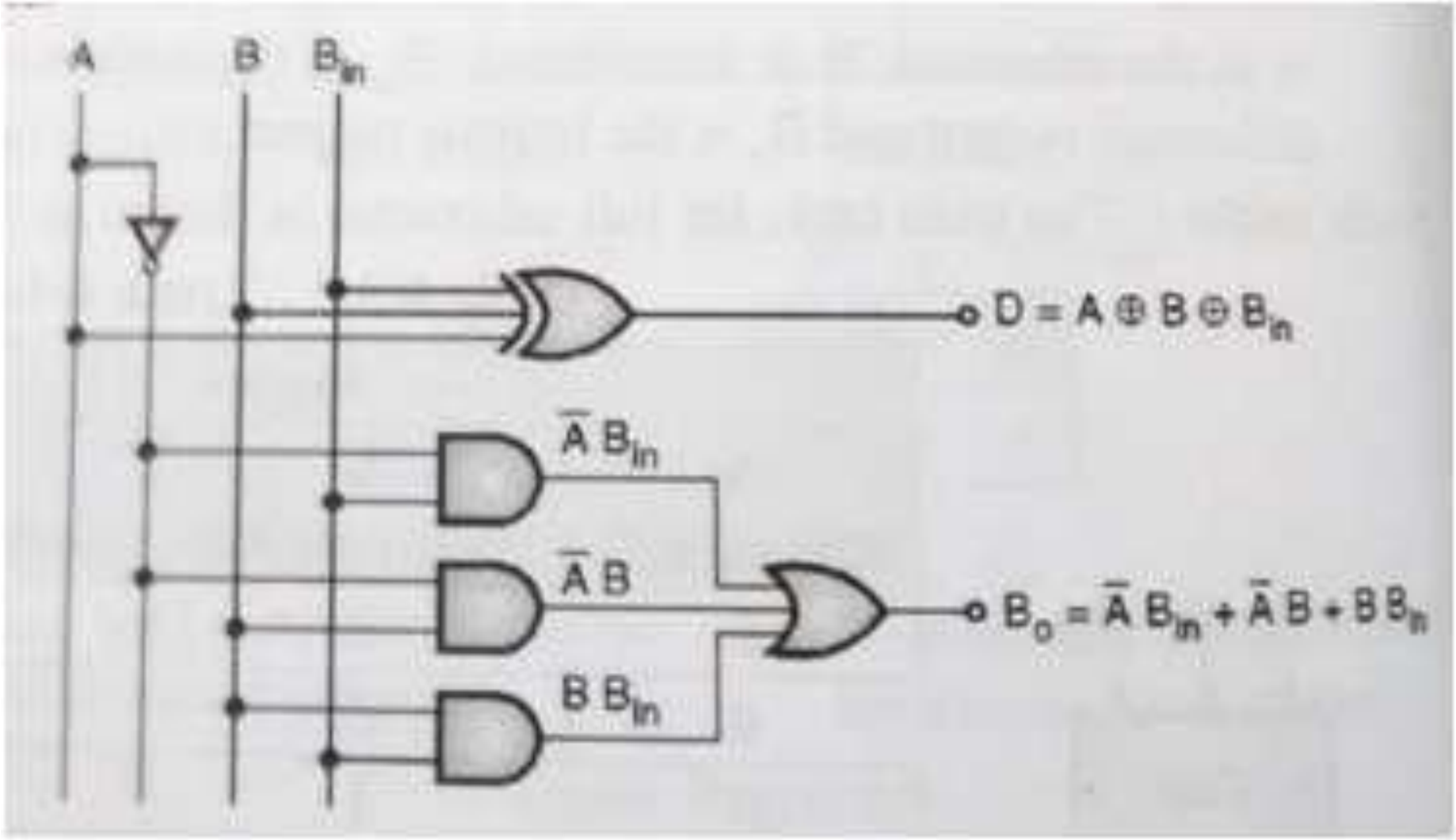
$$D = A \oplus B \oplus B_{in}$$

For B_{in}:

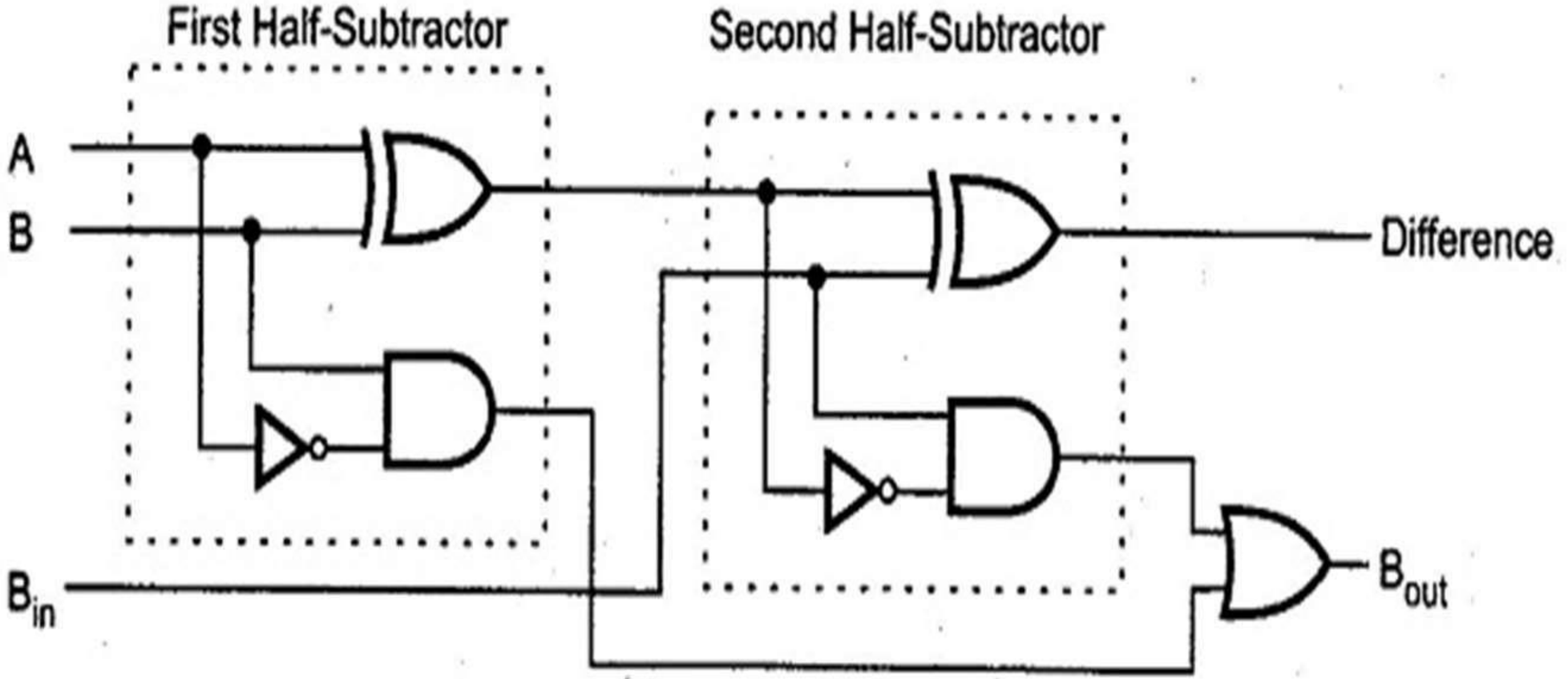


$$B_{out} = \bar{A}\,B + (\bar{A} + B)\,B_{in}$$

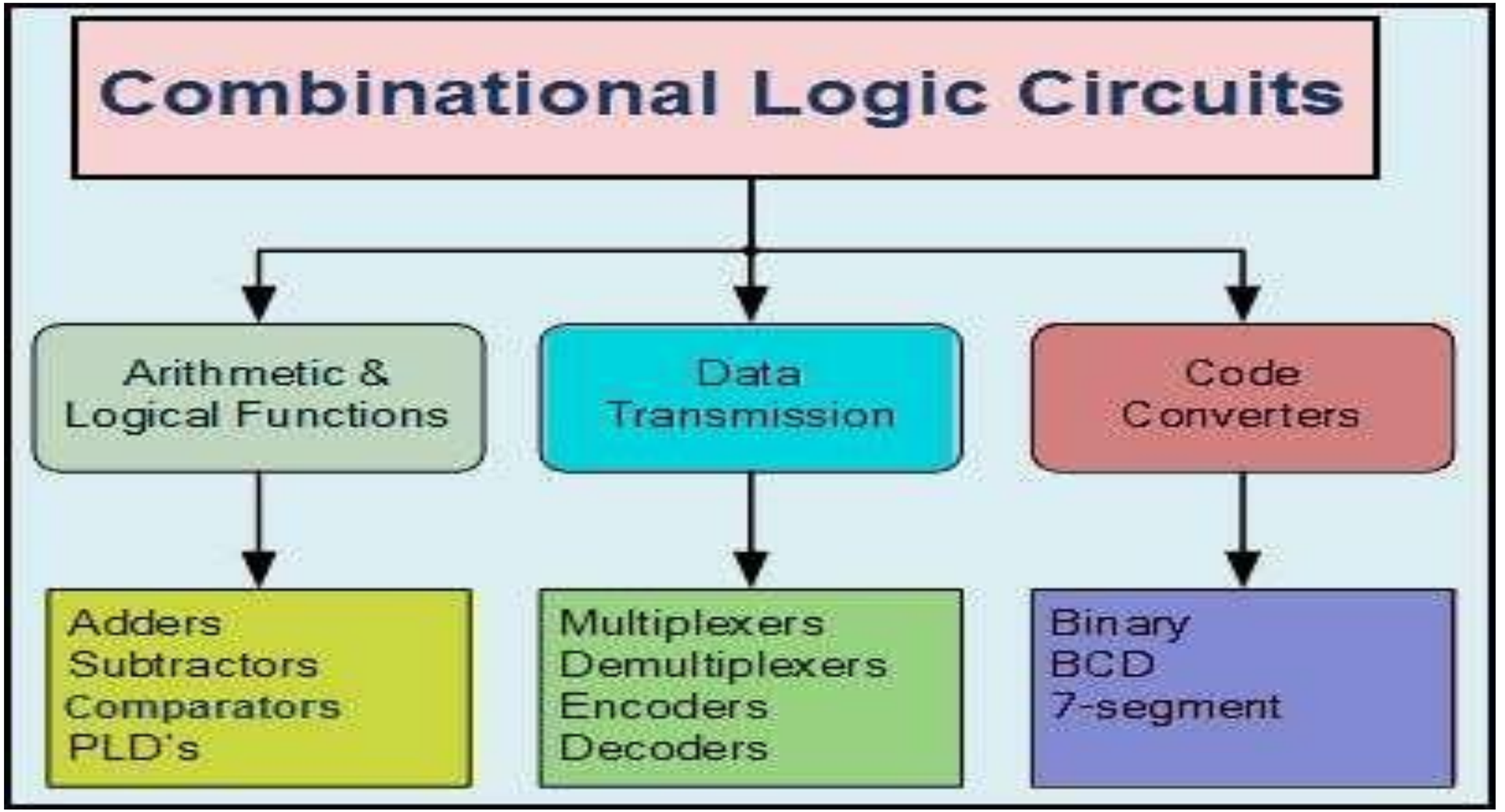
FULL SUBTRACTOR



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?

THANK YOU