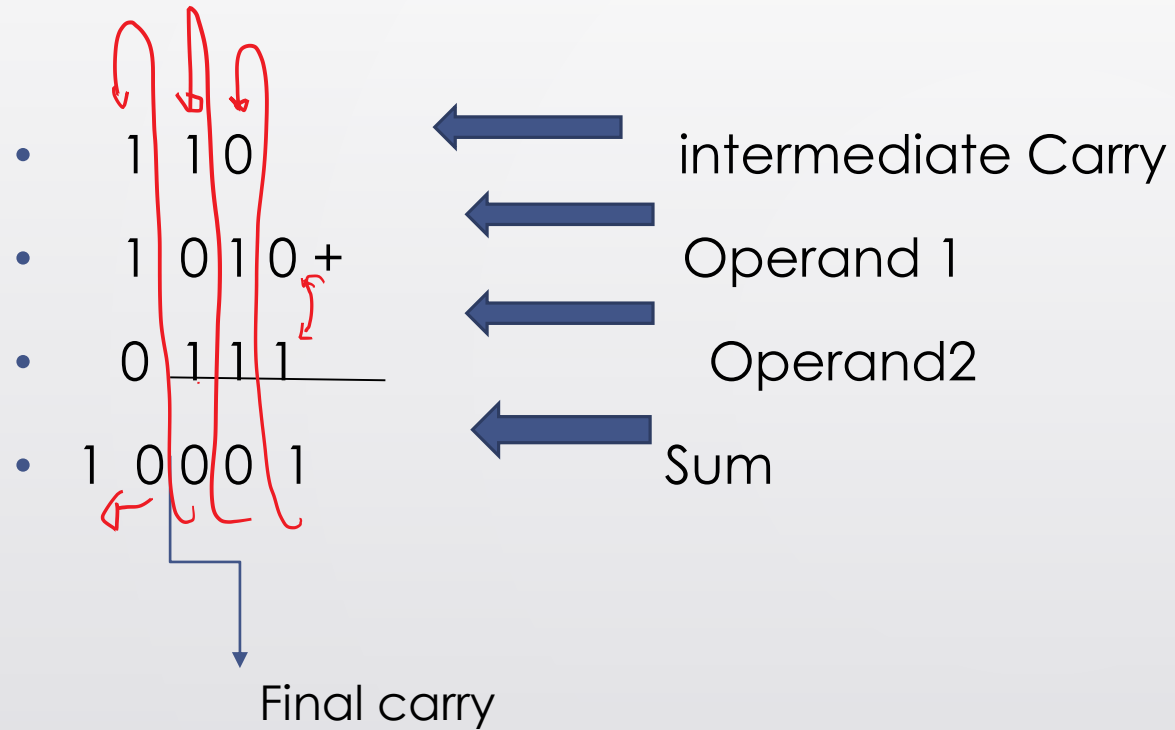




# Binary adders and subtractors

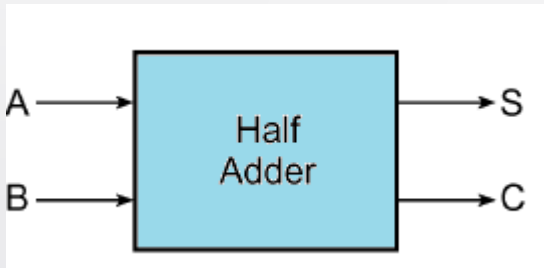
- Half adder, full adder, parallel adder
- Half subtractor , full subtractor, parallel subtractor
- Subtraction using complements, parallel adder/subtractor
- Carry Look ahead adder, Decimal adder

# Binary Addition



# Half adder(HA)

- Adds 2, 1-bit numbers A and B , generates two outputs sum(S) and carry (C).



Expression for sum and carry :

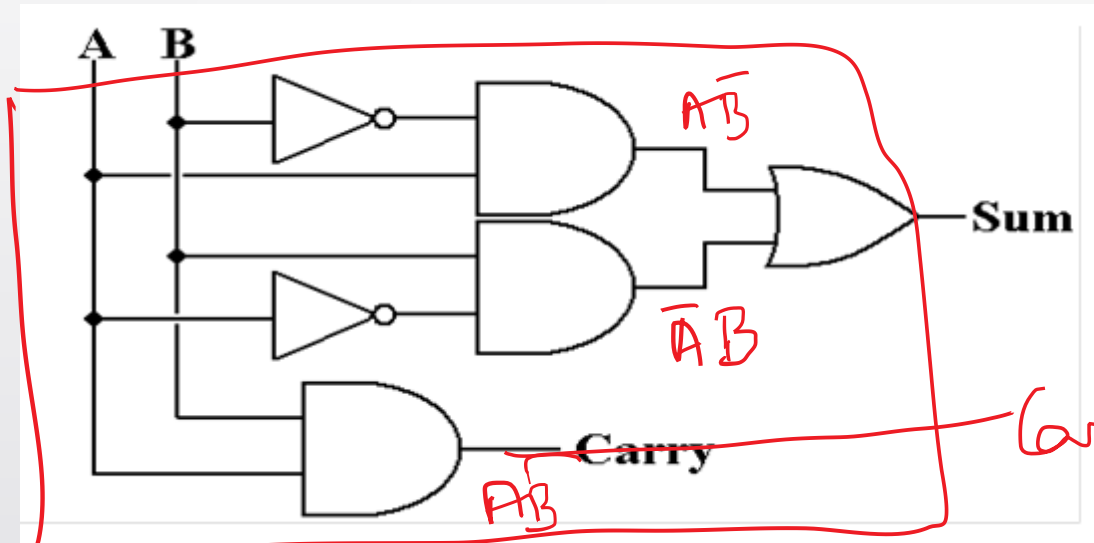
$$S = \bar{A}B + A\bar{B} = \underline{\underline{A \oplus B}}$$

$$C = \underline{\underline{AB}}$$

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

# HA circuit

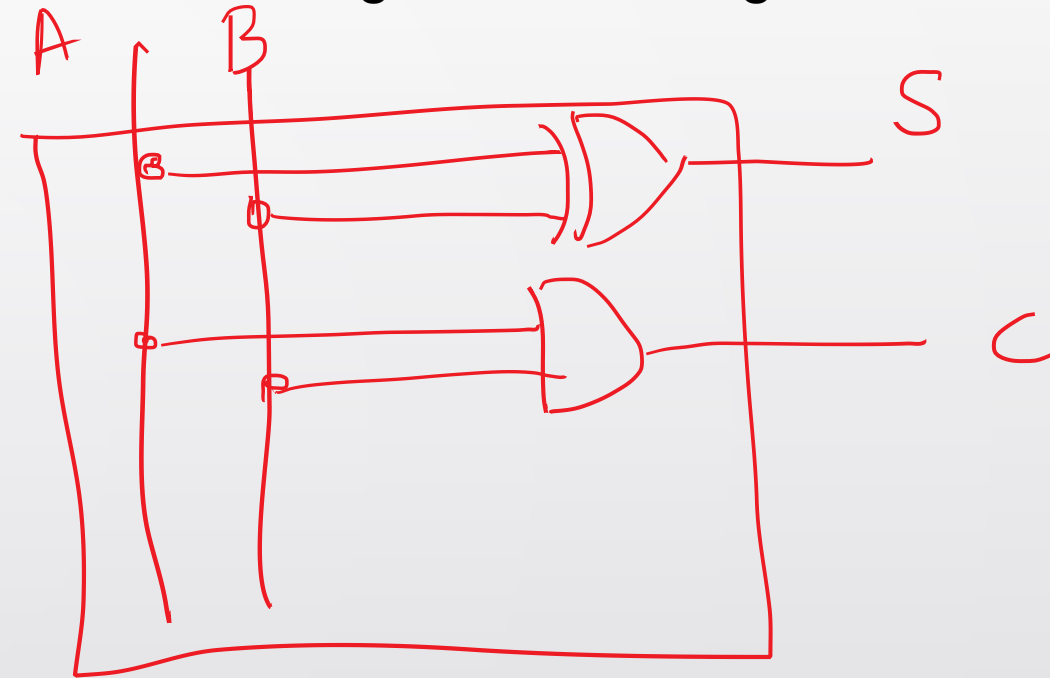
Using basic logic gates



HA

Carry

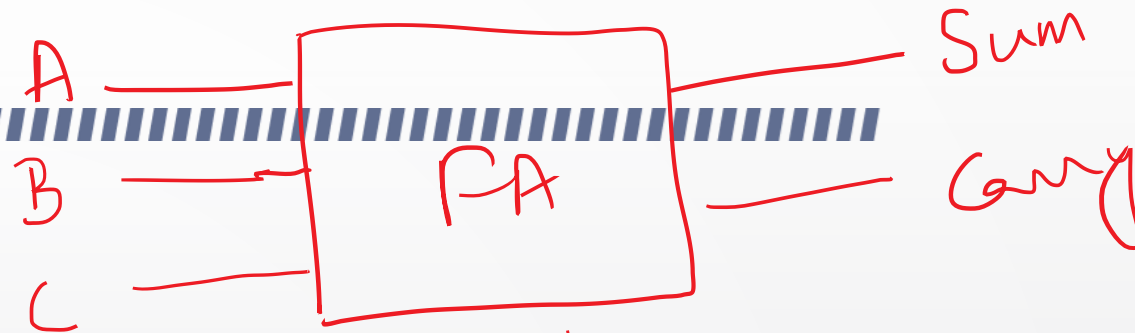
Using XOR and AND gate



# Full adder [FA]

Truth Table

A	B	C	Carry	Sum
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



Carry:-

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

$$\text{Carry} = AB + BC + AC$$

Sum:-

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

$$\begin{aligned}
 \text{Sum} &= \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC \\
 &= \bar{A}[\bar{B}C + B\bar{C}] + A[\bar{B}\bar{C} + BC] \\
 &= \bar{A}[B \oplus C] + A[B \oplus C] = A \oplus B \oplus C
 \end{aligned}$$

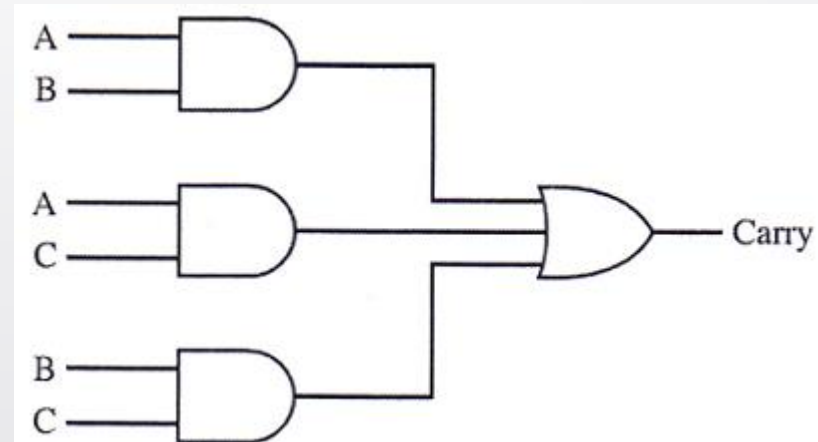
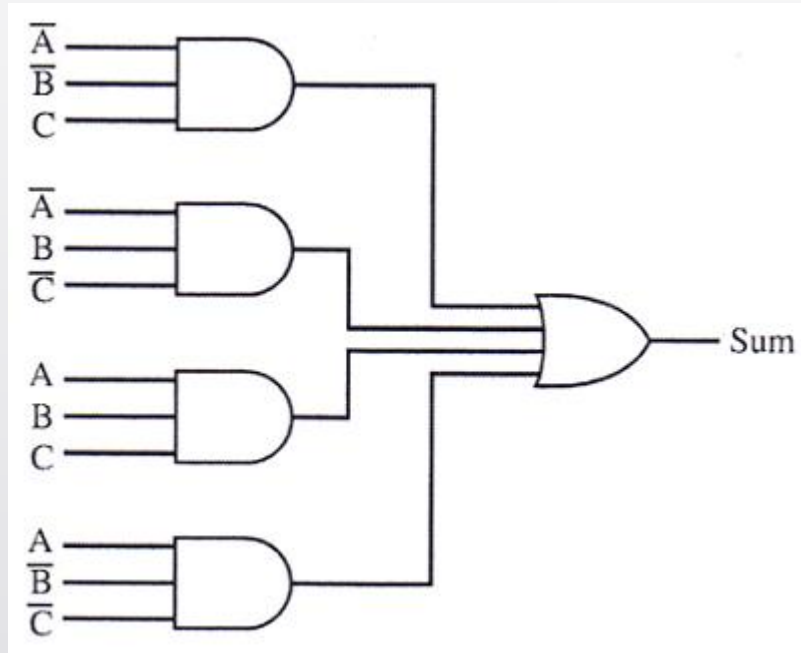
$$\begin{array}{r}
 A \rightarrow 1 \\
 B \rightarrow +1 \\
 C \rightarrow +1 \\
 \hline
 11 \\
 \hline
 11
 \end{array}$$

Sum

Let  $B \oplus C = X$

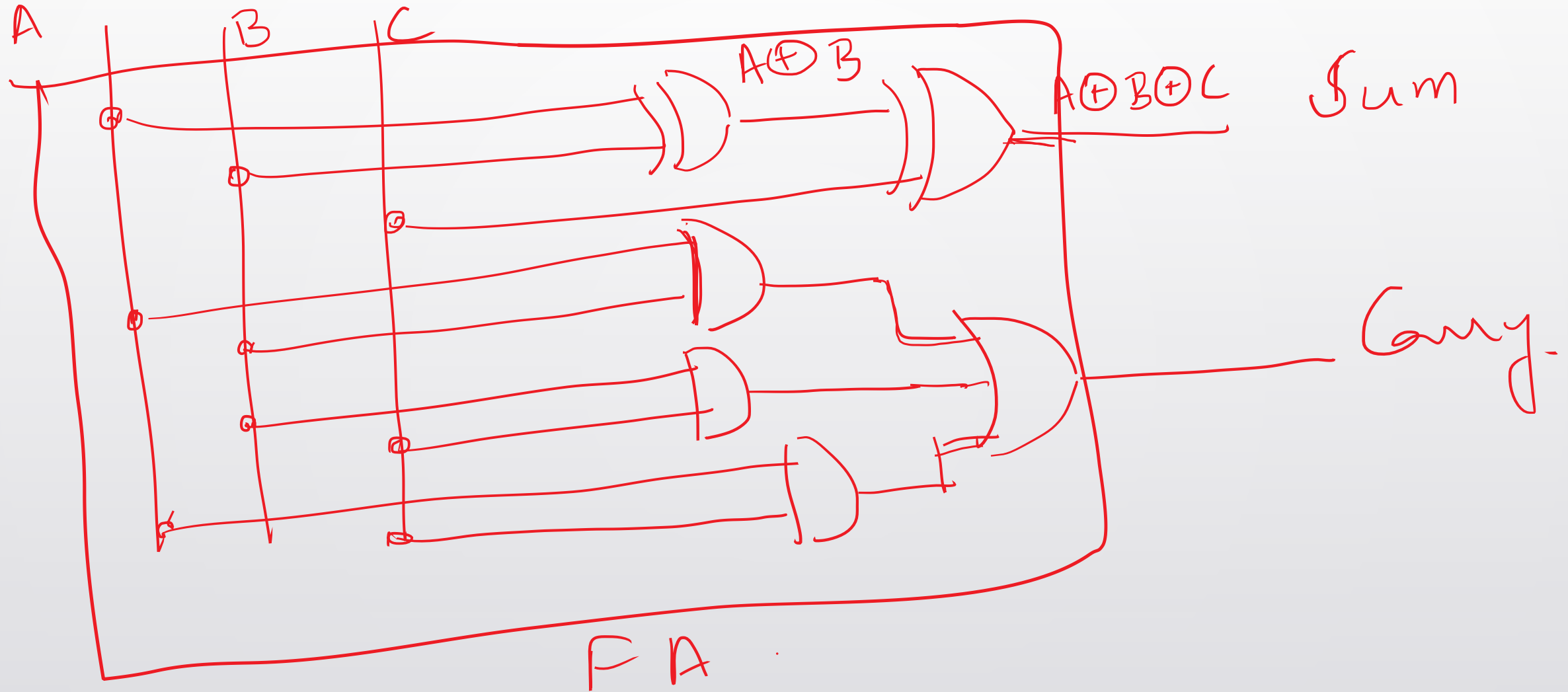
$$\bar{A}X + AX$$

# FA circuit using basic logic gates

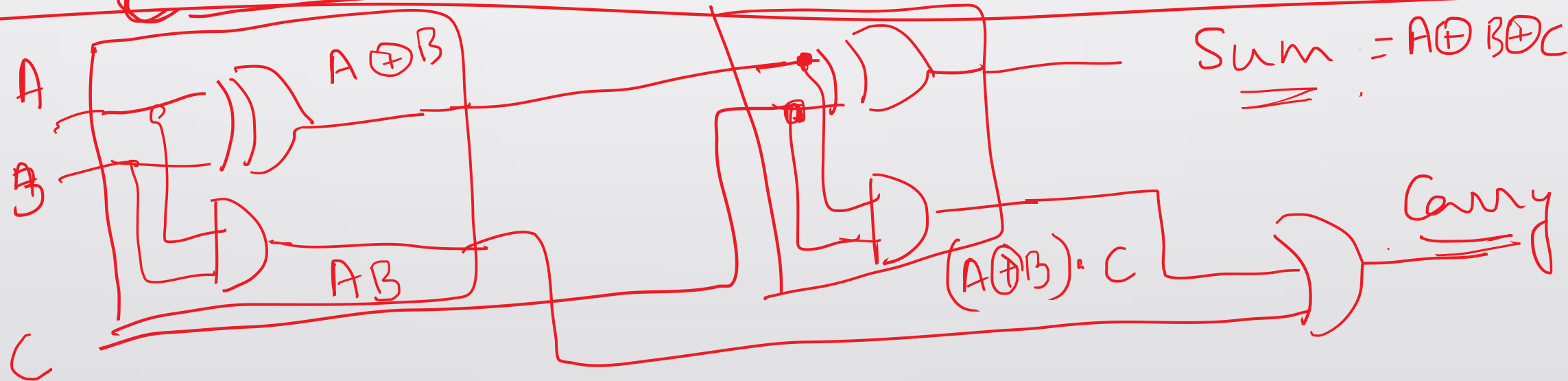
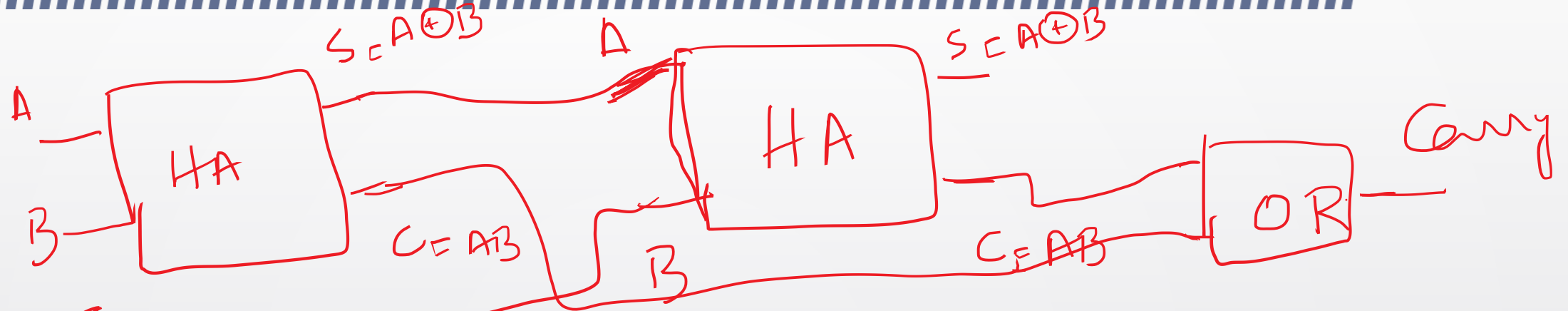




# Full adder circuit using XOR operations



# FA using 2 HA s and one external gate





A	BC			
	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$$\text{Carry} = \bar{A} B C + A \bar{B} C + A B C$$

$$= AB \left[ \cancel{C} + \bar{C} \right] + C \left[ \bar{A} B + A \bar{B} \right]$$

$$= AB + C \left[ A \oplus B \right]$$