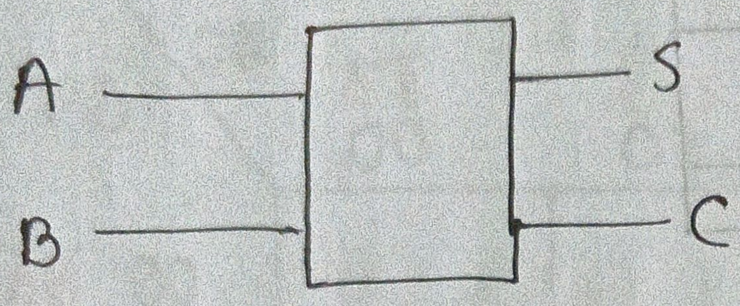
Adder

* Half - Adder

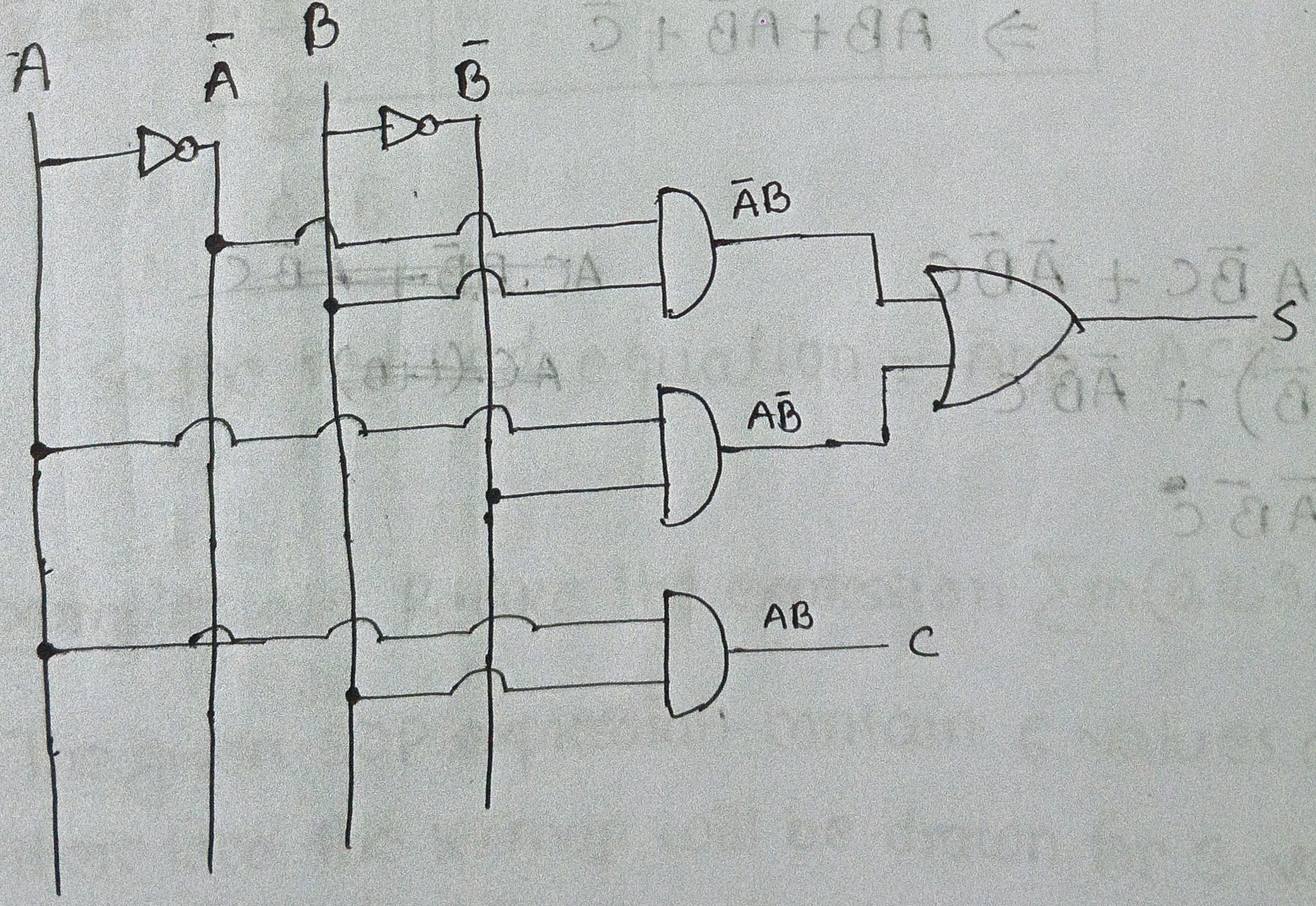
↳ use to add two 1 bit binary digit



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

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

$$C = AB$$



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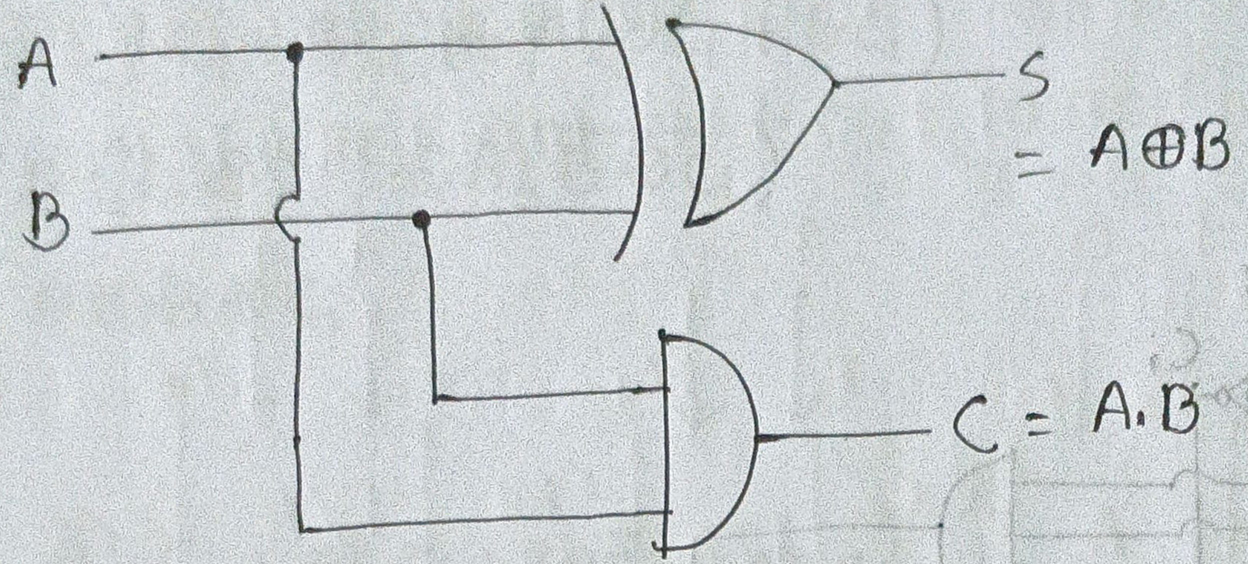
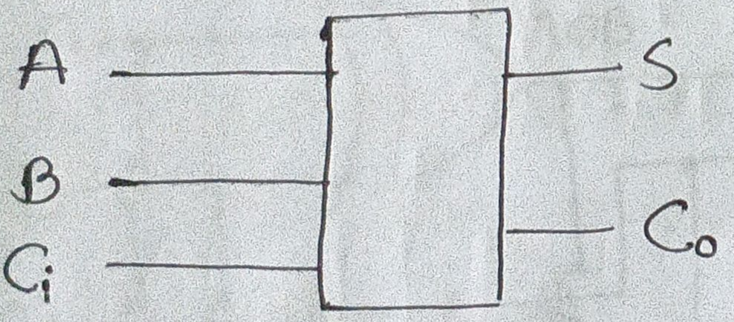


(distributive law)

$$\boxed{C + \bar{C}A = (C + A)}$$

*Full adder

A full adder is a digital circuit that adds three binary numbers and produce the sum and carry.



A	B	C_i	S	C_o
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

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

$$C_o = \bar{A}BC_i + A\bar{B}C_i + AB\bar{C}_i + ABC_i$$

$$= \bar{A}BC_i + A\bar{B}C_i + AB(\bar{C}_i + C_i)$$

$$= \bar{A}BC_i + A\bar{B}C_i + AB$$

$$= \bar{A}BC_i + A(\bar{B}C_i + B)$$

$$= \bar{A}BC_i + A(B + C_i)$$

$$= \bar{A}BC_i + AB + AC_i$$

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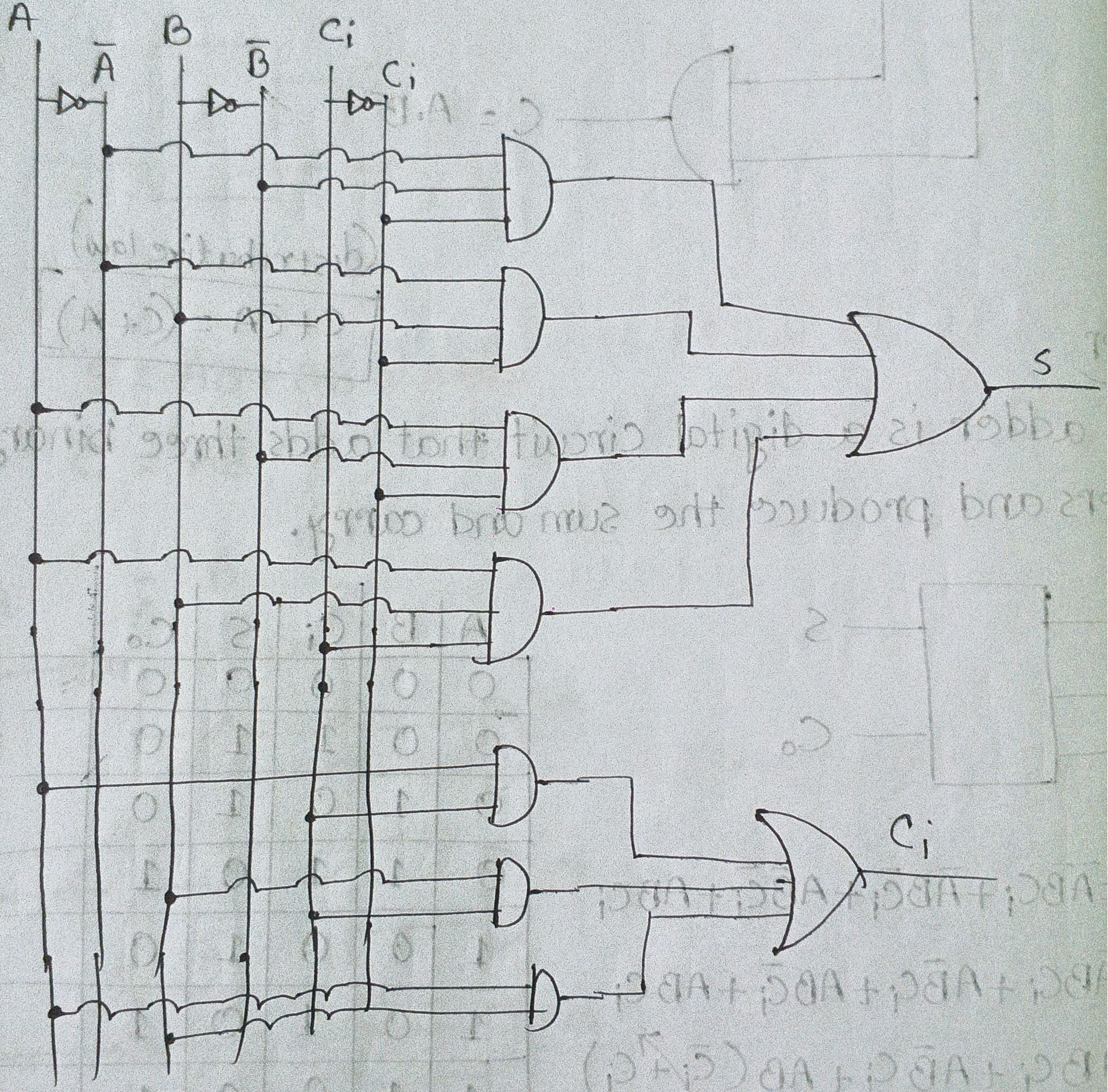
$$= C_i(\bar{A}B + A) + AB$$

$$= C_i(A + B) + AB$$

$$= AC_i + BC_i + AB$$



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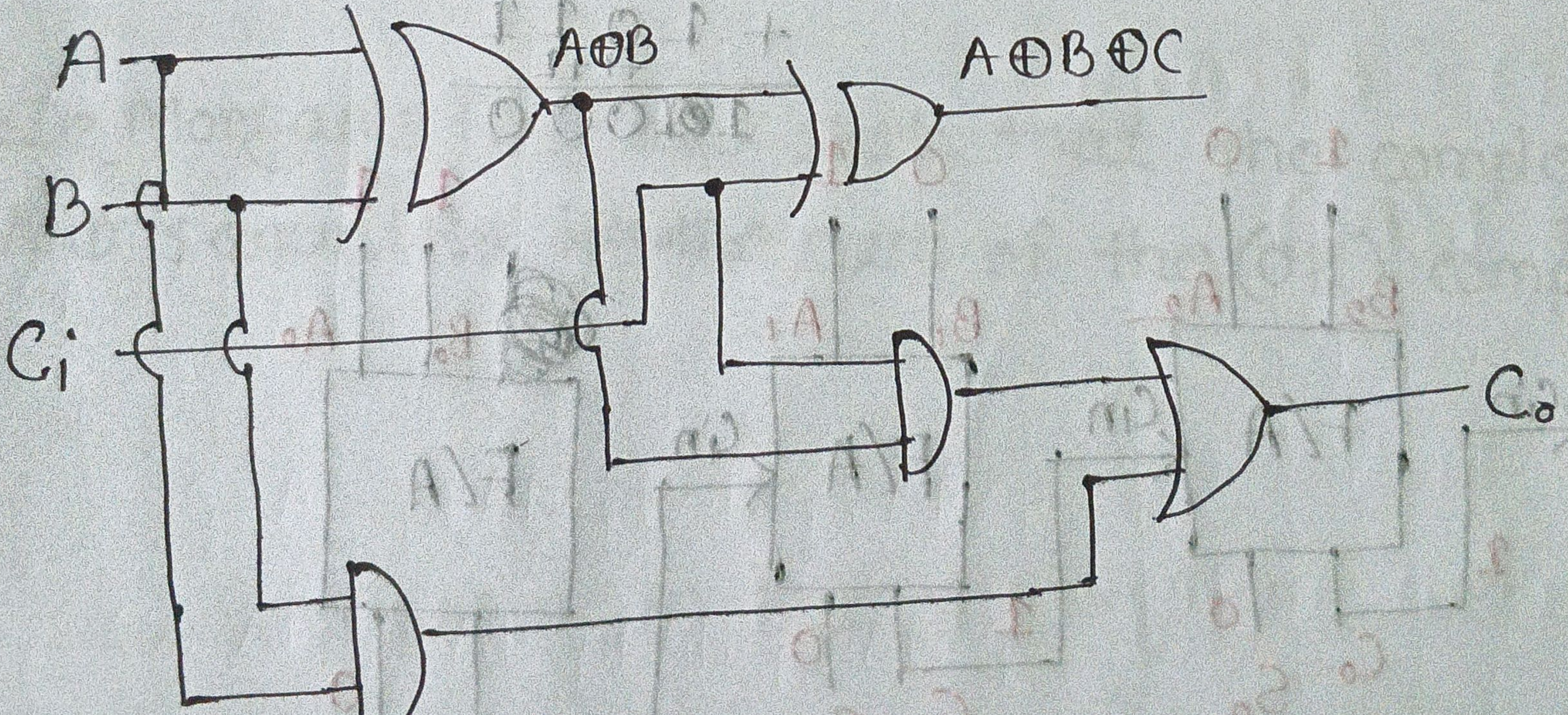
$$S = \bar{A}\bar{B}C_i + \bar{A}B\bar{C_i} + A\bar{B}\bar{C_i} + ABC_i$$
$$= \bar{A}(\bar{B}C_i + B\bar{C_i}) + A(\bar{B}\bar{C_i} + BC_i)$$
$$= \bar{A}(B \oplus C_i) + A(\overline{B \oplus C_i})$$
$$= A \oplus B \oplus C_i$$

$$C_o = \bar{A}BC_i + A\bar{B}C_i + AB\bar{C_i} + ABC_i$$
$$\cancel{= B(\bar{A}}$$
$$= \bar{A}BC_i + A\bar{B}C_i + AB$$
$$= C_i(\bar{A}B + A\bar{B}) + AB$$
$$= C_i(A \oplus B) + AB$$



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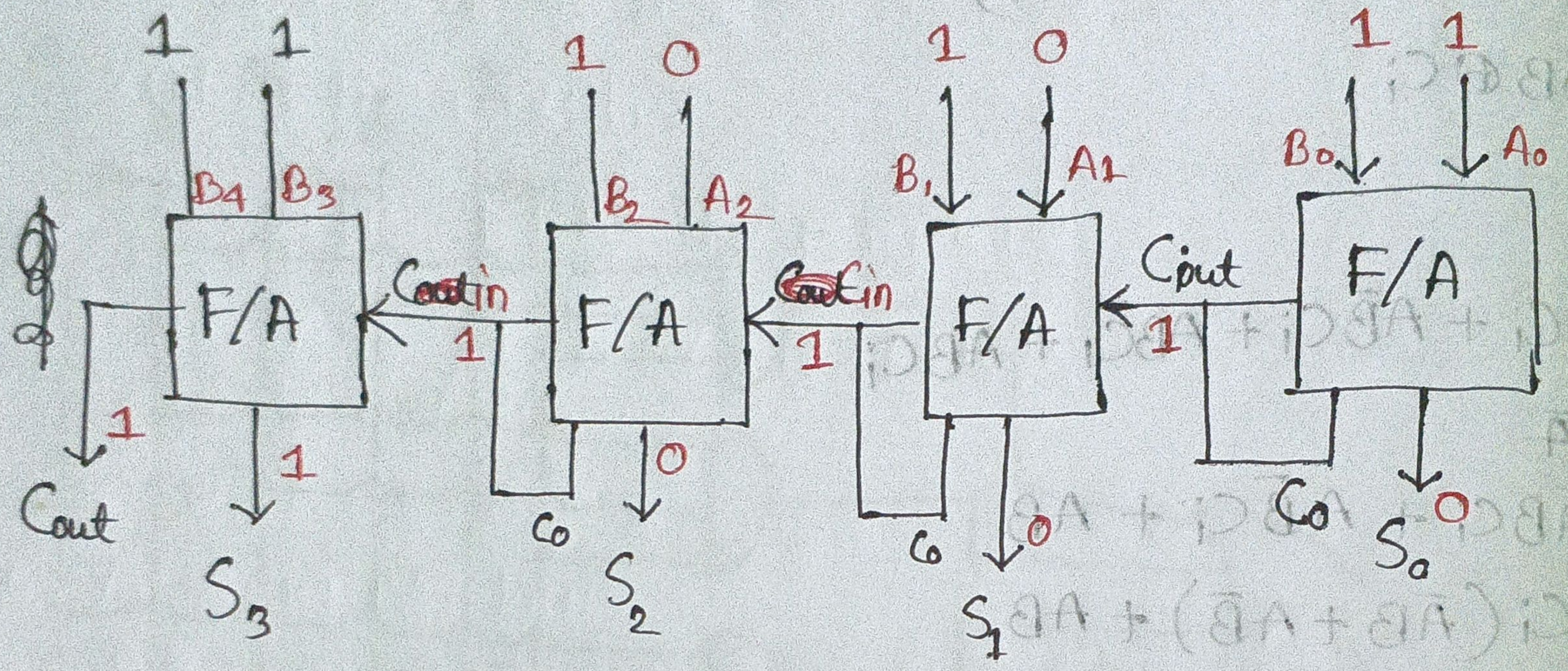
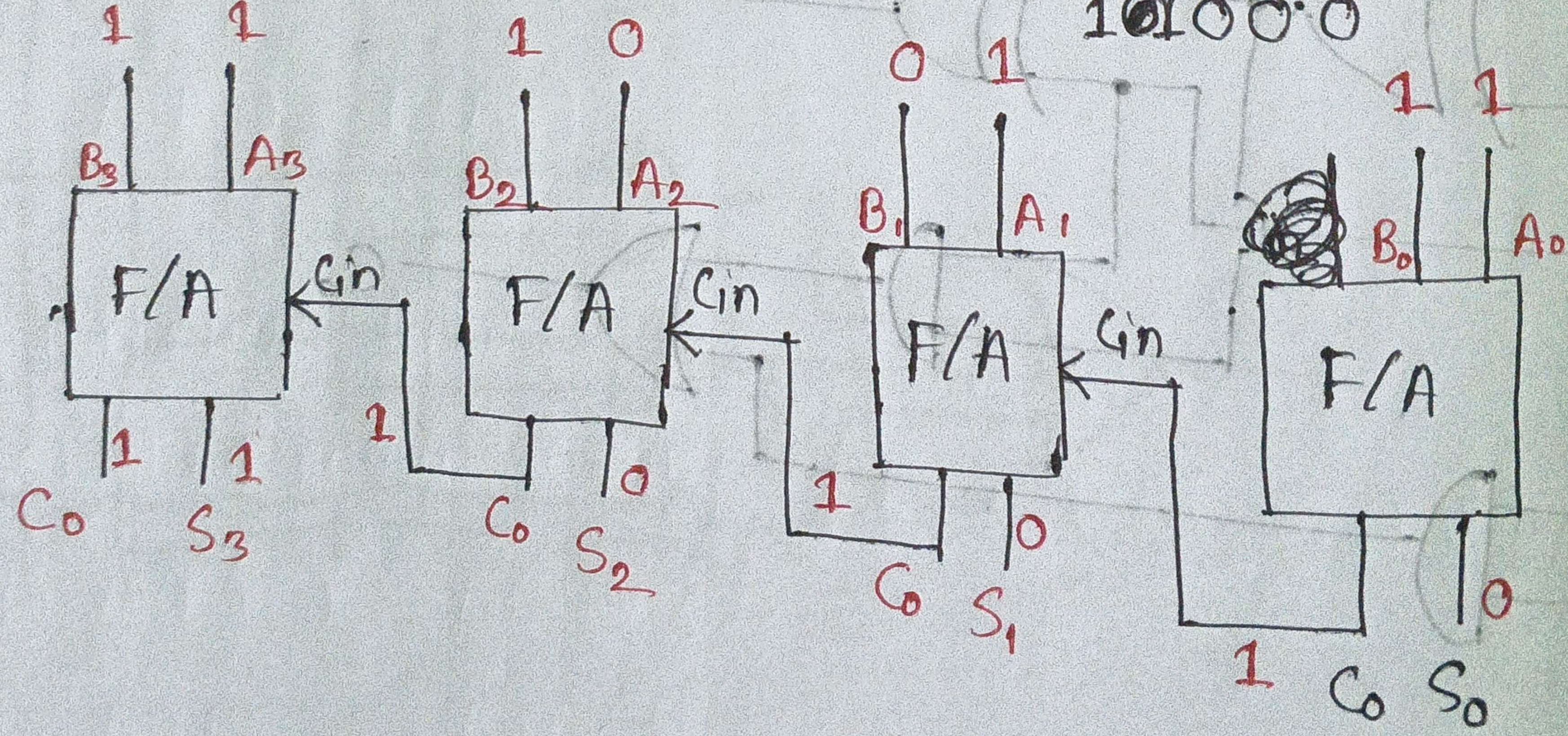
4 bit adder

A 4-bit adder is a digital circuit that helps the CPU in performing addition of two 4 bit binary numbers.



$$\begin{array}{r} 1101 \\ +\ 1011 \\ \hline 11000 \end{array}$$



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