CMOS RCA (H.1)

20151215

References

Some Figures from the following sites

[1] http://pages.hmc.edu/harris/cmosvlsi/4e/index.html
Weste & Harris Book Site

[2] en.wikipedia.org

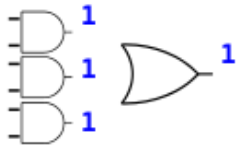
[3] Digital Integrated Circuits : A Design Perspective,
Jan M. Rabaey,
(http://bwrcs.eecs.berkeley.edu/Classes/IcBook/)

[4] Digital Electronics and Design with VHDL
Pedroni

Boolean Algebra

x \ y	0	1
0	0	0
1	1	1

C_i



x \ y	0	1
1	1	0
0	0	1

C_i

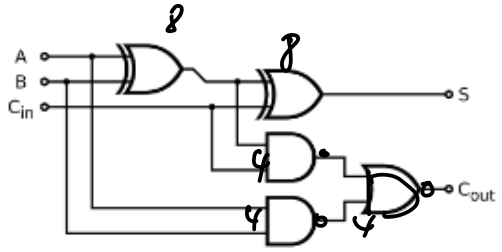
$$C_o = yC_i + xC_i + xy$$

$$S = \bar{x}\bar{y}C_i + \bar{x}y\bar{C}_i + x\bar{y}\bar{C}_i + xyC_i$$

$$\begin{aligned} C_o &= (x+y)C_i + xy \\ &= (\bar{x}y + x\bar{y} + xy)C_i + xy \\ &= (\bar{x}y + x\bar{y})C_i + xy(C_i + 1) \\ &= (x \oplus y)C_i + xy \end{aligned}$$

$$\begin{aligned} S &= (\bar{x}\bar{y} + xy)C_i + (\bar{x}y + x\bar{y})\bar{C}_i \\ &= \overline{(x \oplus y)}C_i + (x \oplus y)\bar{C}_i \\ &= (x \oplus y) \oplus C_i \end{aligned}$$

12
16
28

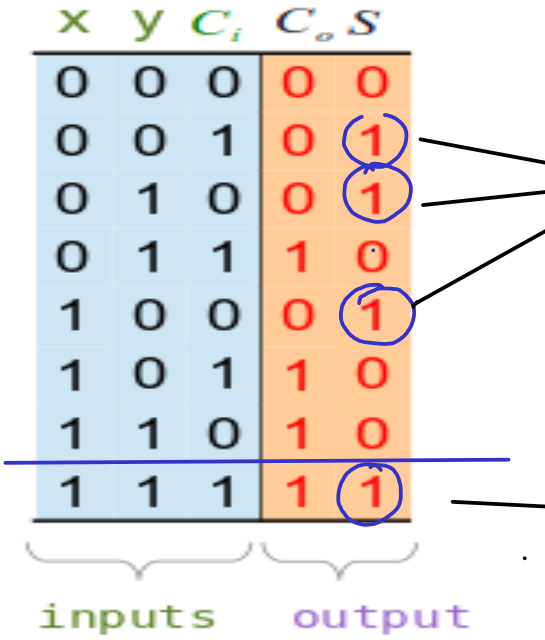


$$C_o = AC_i + BC_i + AB$$

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

three '1's

only one '1'



x	y	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

inputs output

S= 1 conditions :

No carry out conditions
– all zero input

$[\overline{C}_o \cdot (A + B + C)]$

+

all one input condition

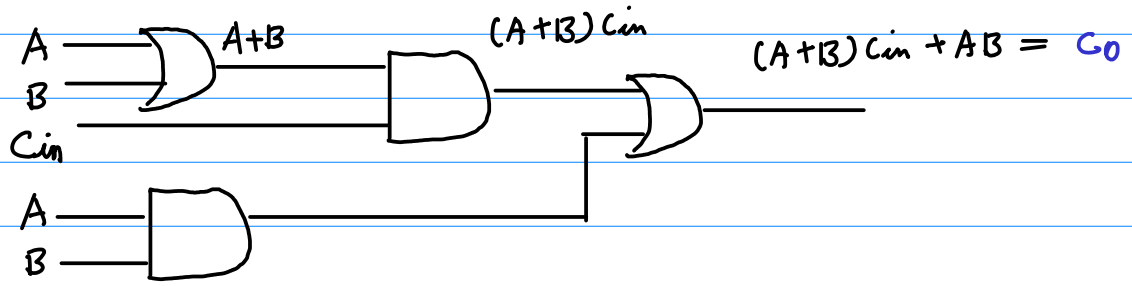
$[A \cdot B \cdot C]$

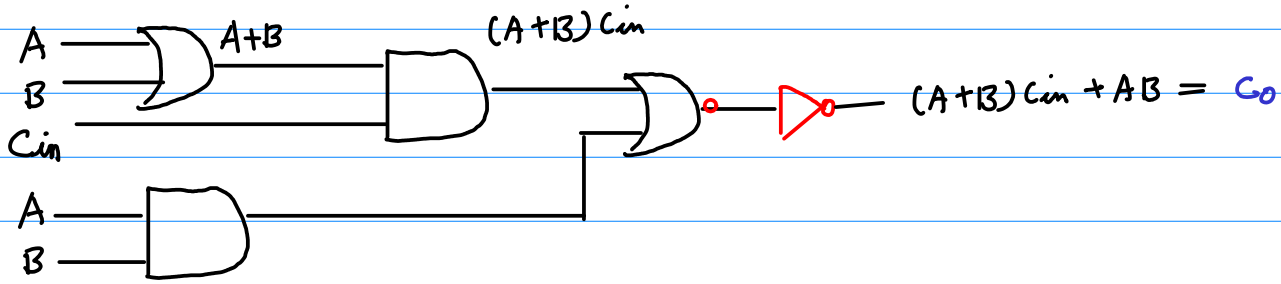
$$C_o = AC_i + BC_i + AB$$

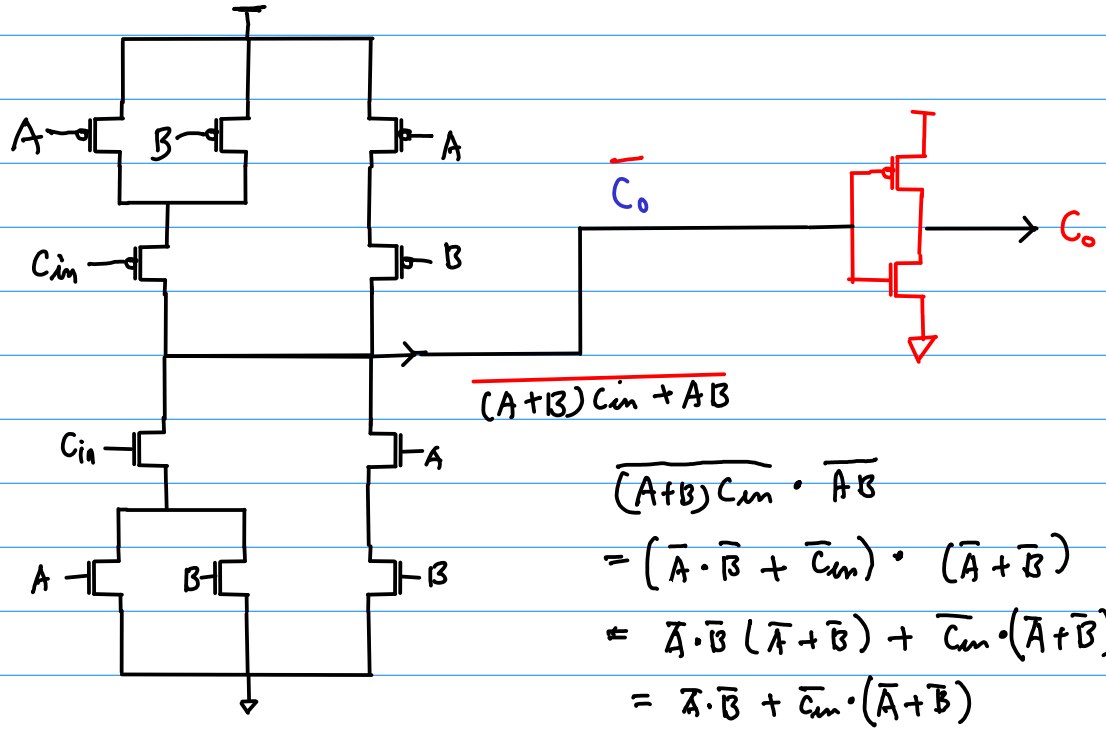
$$S = \overline{C}_o \cdot (A + B + C) + A \cdot B \cdot C$$

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

$$S = \overline{C_o} \cdot (A + B + C_i) + A \cdot B \cdot C_i$$







$$\overline{(A+B)C_{in} \cdot \overline{AB}}$$

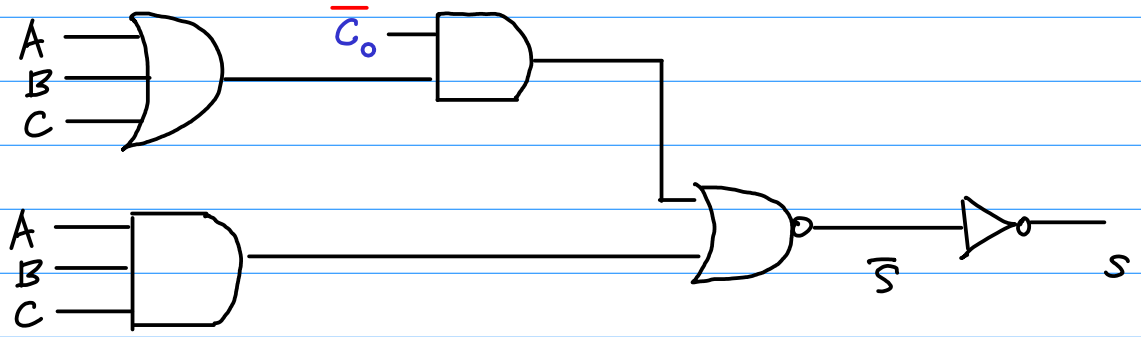
$$= \left(\overline{A} \cdot \overline{B} + \overline{C_{in}}\right) \cdot \left(\overline{A} + \overline{B}\right)$$

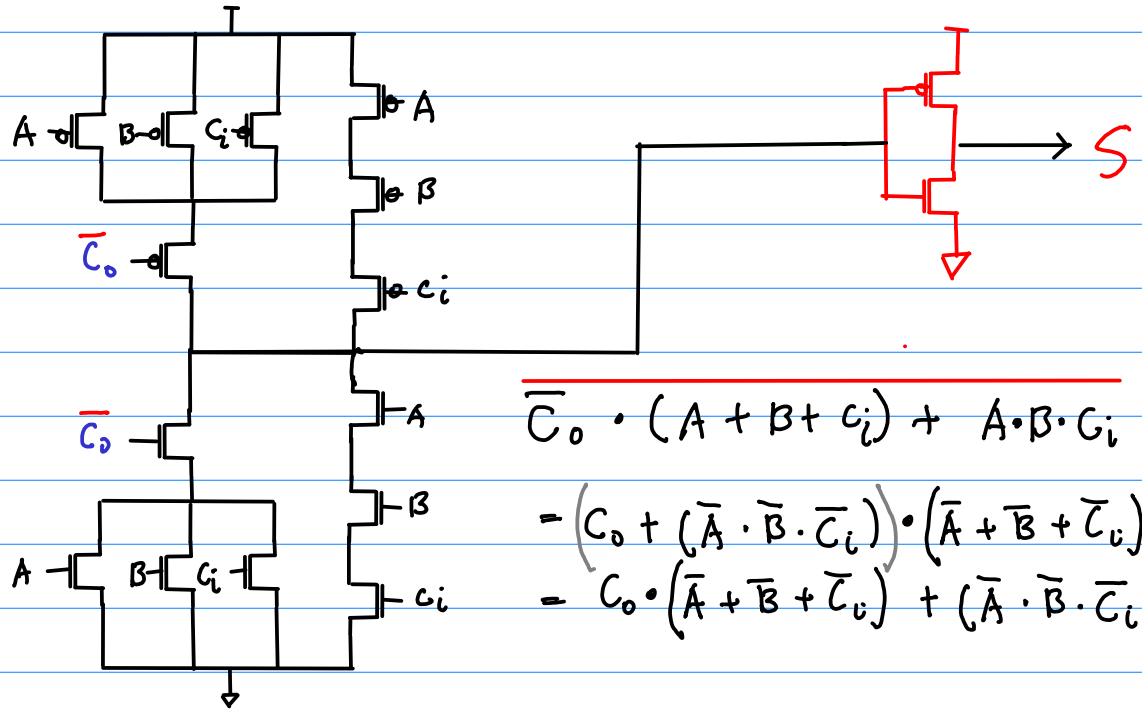
$$= \overline{A} \cdot \overline{B}\left(\overline{A} + \overline{B}\right) + \overline{C_{in}} \cdot \left(\overline{A} + \overline{B}\right)$$

$$= \overline{A} \cdot \overline{B} + \overline{C_{in}} \cdot \left(\overline{A} + \overline{B}\right)$$

$$C_o = AC_i + BC_i + AB$$

$$S = \overline{C}_o \cdot (A + B + C_i) + A \cdot B \cdot C_i$$

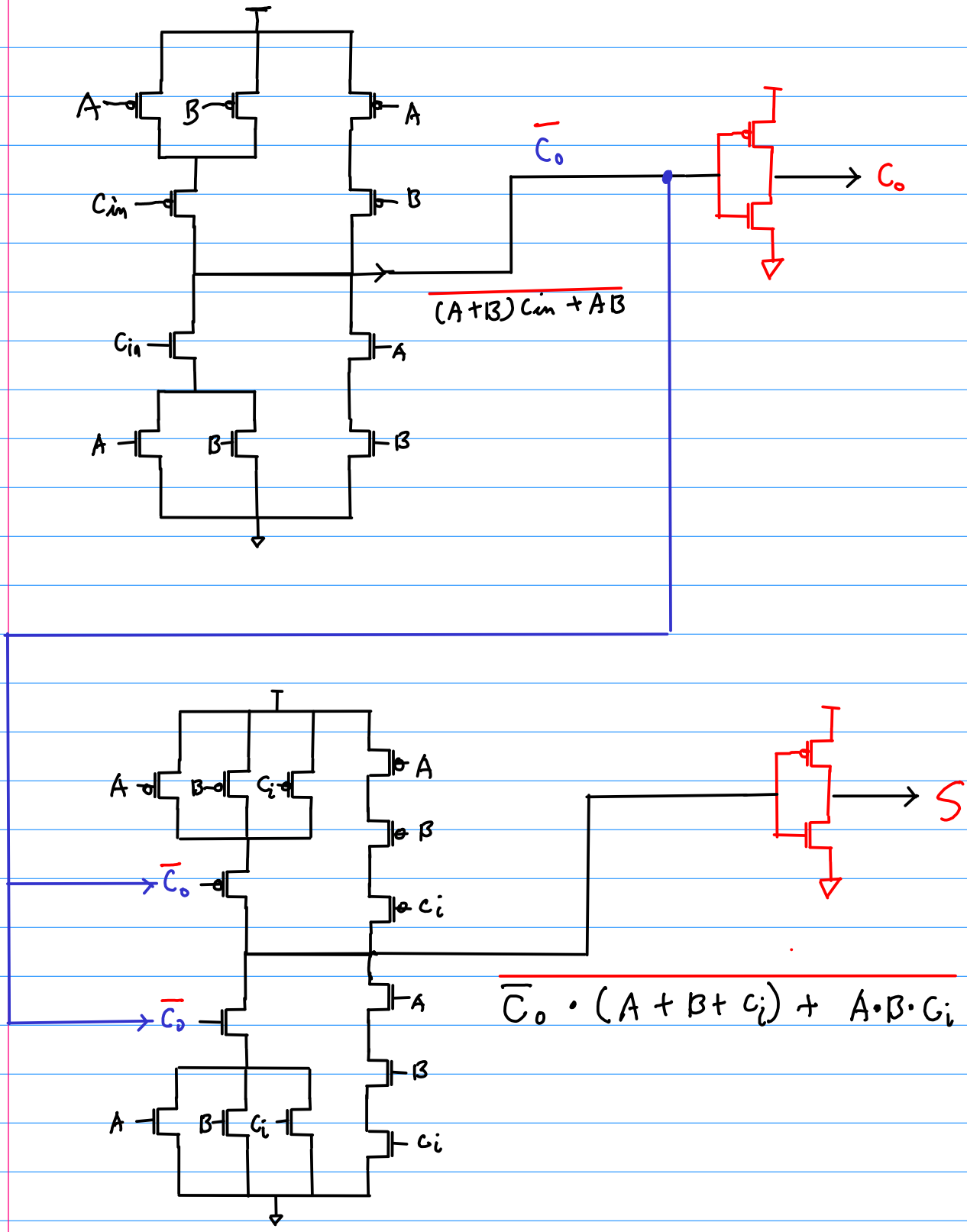




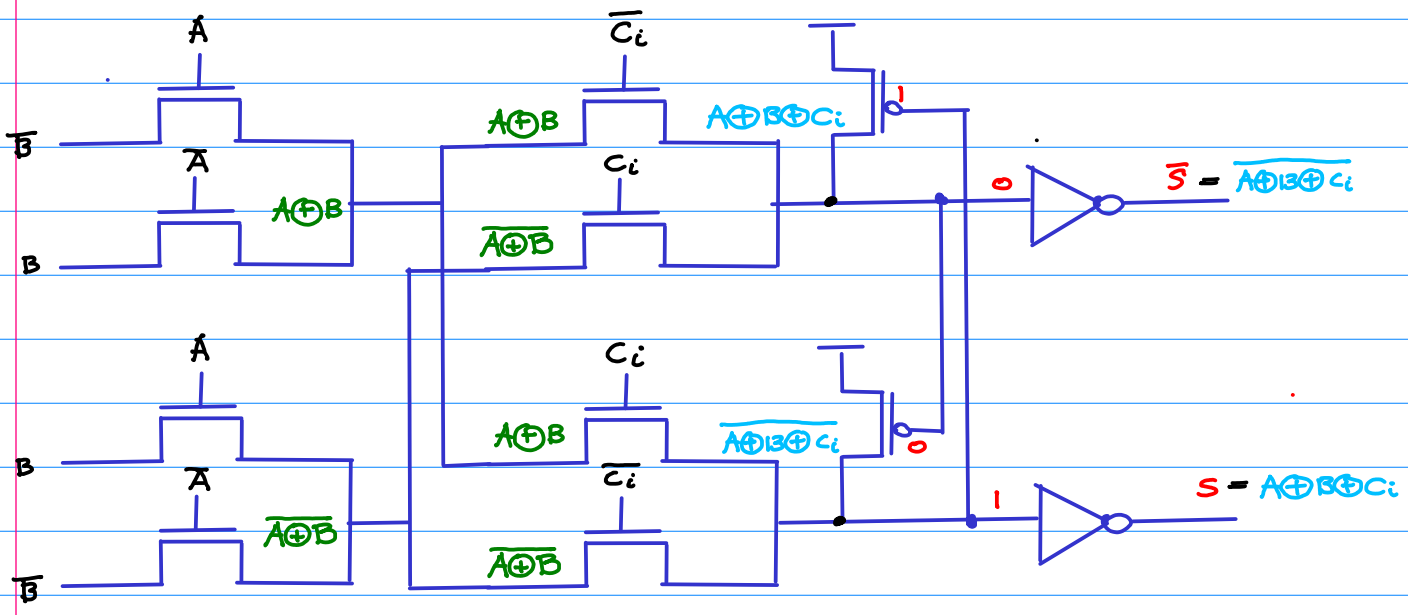
$$\overline{\overline{C}_o \cdot (A + B + C_i) + A \cdot B \cdot C_i}$$

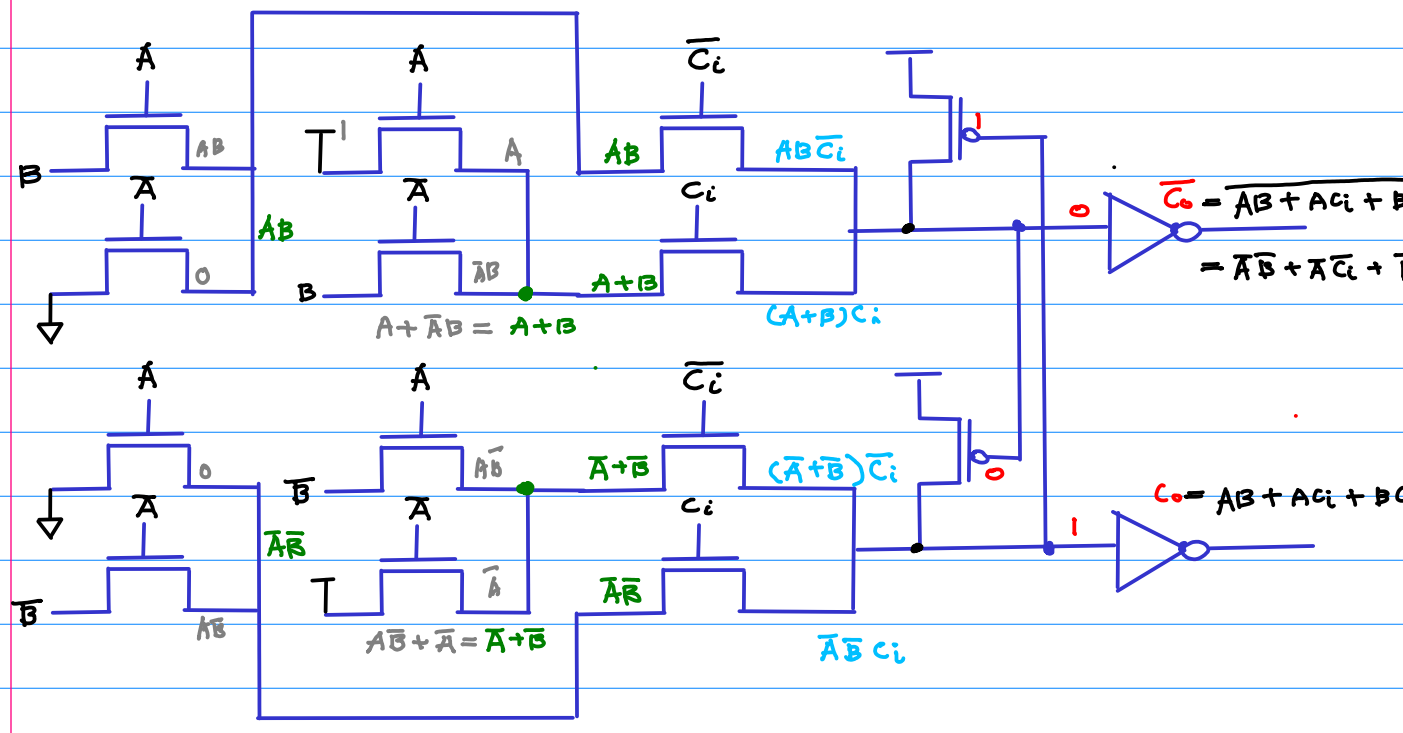
$$= \left(C_o + (\overline{A} \cdot \overline{B} \cdot \overline{C}_i)\right) \cdot \left(\overline{A} + \overline{B} + \overline{C}_i\right)$$

$$= C_o \cdot \left(\overline{A} + \overline{B} + \overline{C}_i\right) + (\overline{A} \cdot \overline{B} \cdot \overline{C}_i)$$

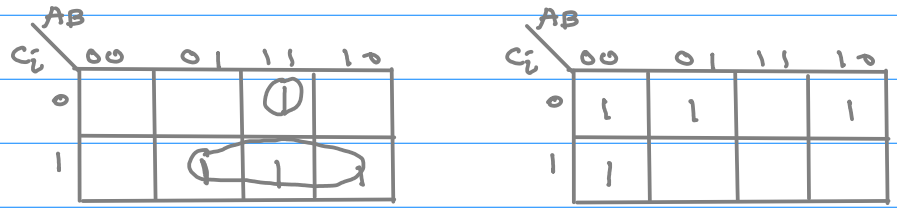

A
B
A
Cin
B
$\overline{C_o}$
C_o
$(A+B)C_{in}+AB$
Cin
A
A
B
B
A
B
Ci
A
B
Ci
$\overline{C_o}$
$\overline{C_o}$
A
B
Ci
A
B
Ci
S
$\overline{C_o}\cdot(A+B+C_i)+A\cdot B\cdot C_i$

CPL (FA)





$AB\overline{C_i} + (A+B)C_i$



CPL (Carry Propagate Adder)

or RCA (Ripple Carry Adder)