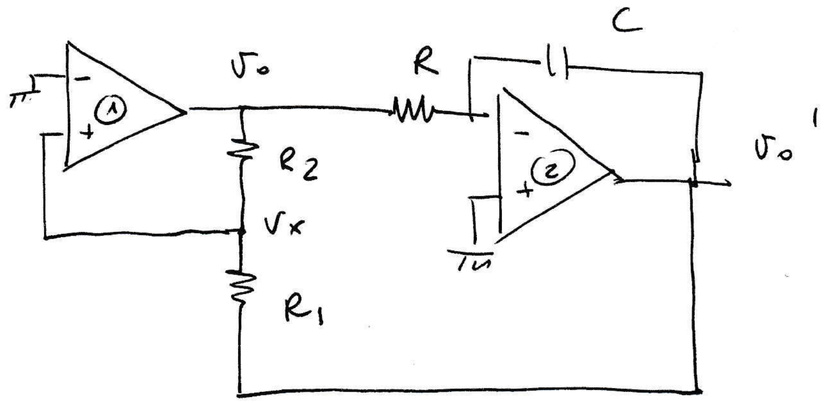
1)



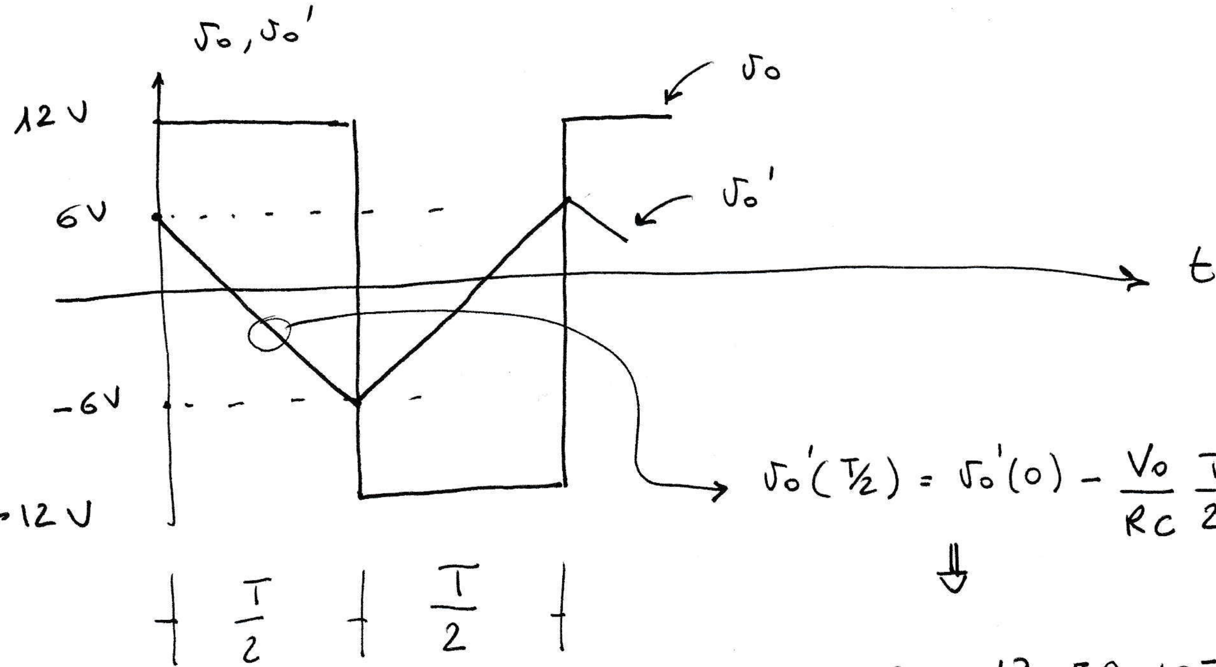
$$V_x = v_o \beta + v_o'(1-\beta)$$

→ soglia di scatto (1) = 0V

$$V_x = v_o \beta + v_o'(1-\beta) = 0 \Rightarrow v_o' = -v_o \frac{\beta}{(1-\beta)}$$

$$\beta = \frac{R_1}{R_1+R_2}, \quad 1-\beta = \frac{R_2}{R_1+R_2} \Rightarrow \frac{\beta}{1-\beta} = \frac{R_1}{R_2}$$

$$v_o = \begin{cases} 12\,V = V_o \\ -12\,V = -V_o \end{cases} \Rightarrow |v_o'|_{MAX} = 6\,V \Leftrightarrow \boxed{\frac{R_1}{R_2} = \frac{1}{2}}$$



$$v_o'(T/2) = v_o'(0) - \frac{V_o}{RC}\frac{T}{2}$$

$$\Downarrow$$

$$-6 = 6 + \frac{12}{RC} 50 \cdot 10^{-6}$$

$$\frac{12}{RC} \cdot 50 \cdot 10^{-6} = 12 \quad \Rightarrow \quad RC = 50 \cdot 10^{-6}$$

Possibile soluzione, tenendo conto che la max corrente erogata dall'AO ① è

$$\frac{V_o - (-6V)}{R_1 + R_2} + \frac{V_o}{R} = \frac{18V}{R_1+R_2} + \frac{12V}{R} = \frac{18V}{3R_1} + \frac{12V}{R} =$$

$$= \frac{6V}{R_1} + \frac{12V}{R}$$

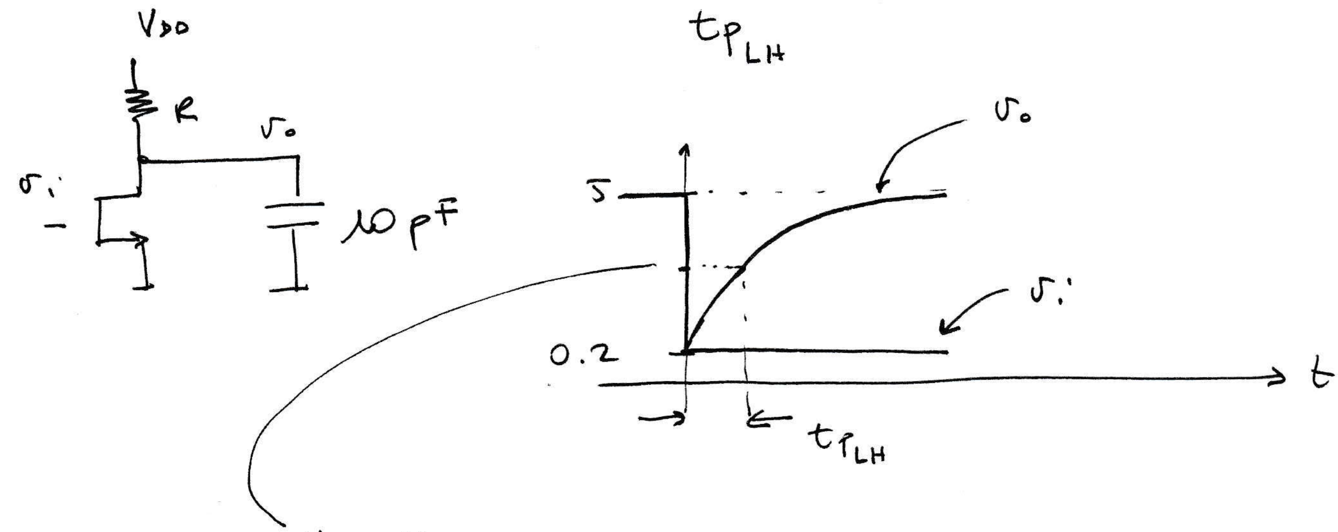
$R_1 = 10\,k\Omega$

$R_2 = 20\,k\Omega$

$R = 10\,k\Omega$

$$C = \frac{50 \cdot 10^{-6}}{10 \cdot 10^3} = 5\,nF$$

2)



$$\frac{V_{OH} + V_{OL}}{2} = 2.6\,V$$

legge di carica del condensatore

$$v_o(t) = \left[V_o(\infty) - v_o(0)\right]\left(1 - e^{-t/RC}\right) + v_o(0)$$

$$v_o(t_{PLH}) = 2.6\,V = 4.8\,V \cdot \left(1 - e^{-\frac{t_{PLH}}{RC}}\right) + 0.2\,V$$

$$\left(1 - e^{-\frac{t_{PLH}}{RC}}\right) = \frac{2.4}{4.8} = \frac{1}{2}$$

$$e^{-\frac{t_{PLH}}{RC}} = \frac{1}{2} \Rightarrow -\frac{t_{PLH}}{RC} = -\ln 2$$

$$\Rightarrow t_{PLH} = RC \ln 2$$

$$t_{PLH} = 10 \cdot 10^{-9}\,s \Rightarrow R^*C = \frac{10 \cdot 10^{-9}}{\ln 2} =$$

e, con $C = 10 \cdot 10^{-12}\,F$

$$\Rightarrow R^* = \frac{\cancel{10} \cdot 10^{-9}}{\ln 2 \cdot \cancel{10} \cdot 10^{-\cancel{12}\,3}} =$$

$$= \frac{10^3}{\ln 2} = 1.442\,k\Omega$$

$$\boxed{R < R^* \text{ garantisce } t_{PLH} < 10\,ns}$$

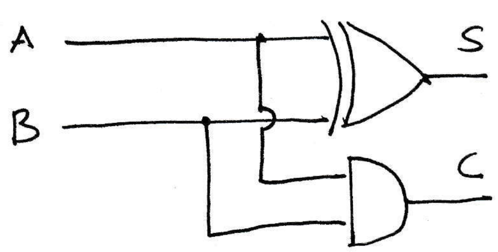
3 Half Adder

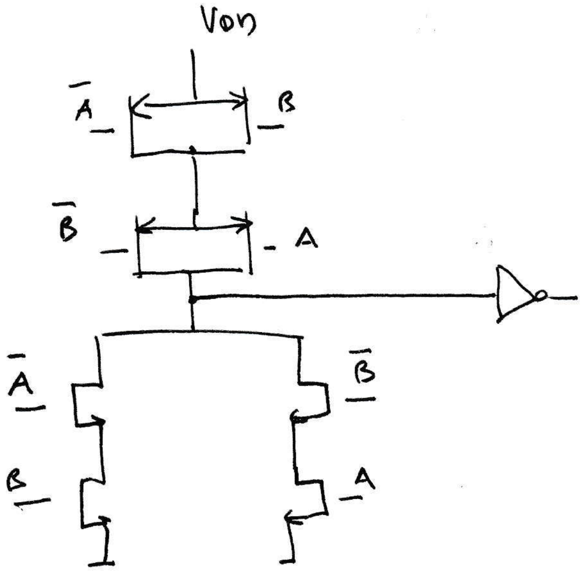
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

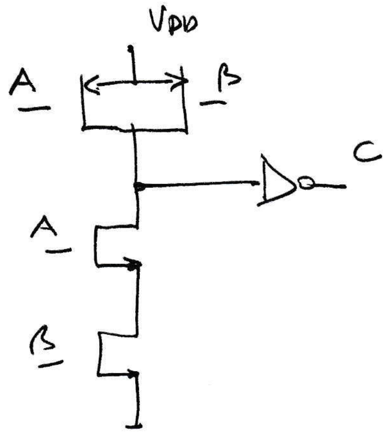
$\rightarrow$

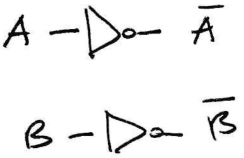
$$S = A \oplus B = \bar{A} \cdot B + \bar{B} A$$

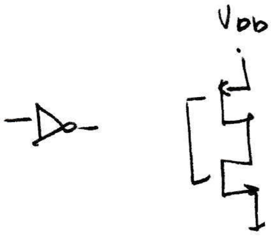
$$C = A \cdot B$$





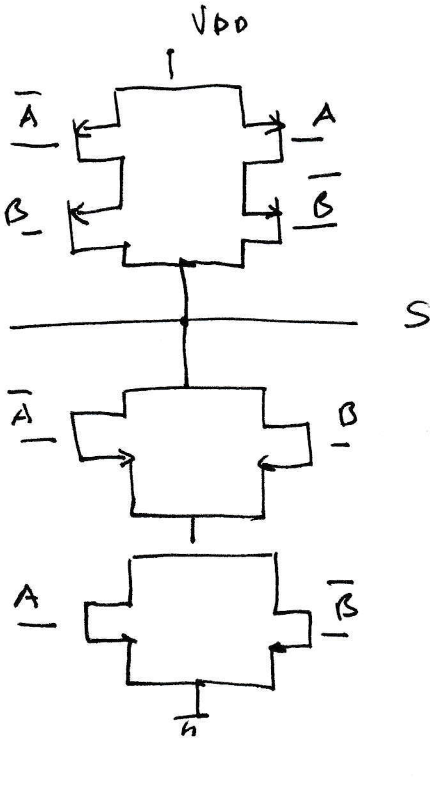






Oppure, meglio

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



$$C = AB = \overline{\overline{A}+\overline{B}}$$