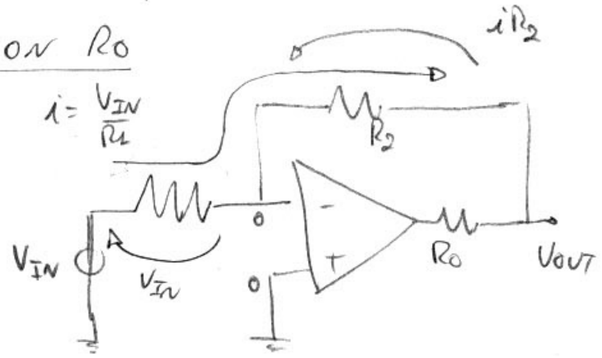
ESERCIZIO 1

(A) SENZA R_0

$$G_{ID}(0) = -\frac{R_2}{R_1} = -12$$

CON R_0

$i = \frac{V_{IN}}{R_1}$



$V^- \simeq V^+ = 0$

$i = \frac{V_{IN}}{R_1}$

$V_{OUT} = V^- - V_{R2} = 0 - iR_2$

$= -\frac{R_2}{R_1} V_{IN} \iff$

$$\boxed{G_{ID} = -\frac{R_2}{R_1} = -12}$$

(B) $G(0) = \frac{G_{ID}(0)}{1 - \frac{1}{G_{LOOP}(0)}} \simeq G_{ID}(0)\left(1 + \frac{1}{G_{LOOP}(0)}\right) \Rightarrow$ $1/G_{LOOP}(0)$ è la differenza percentuale fra G e G_{ID}

(≃ se $G_{LOOP} \gg 1$)

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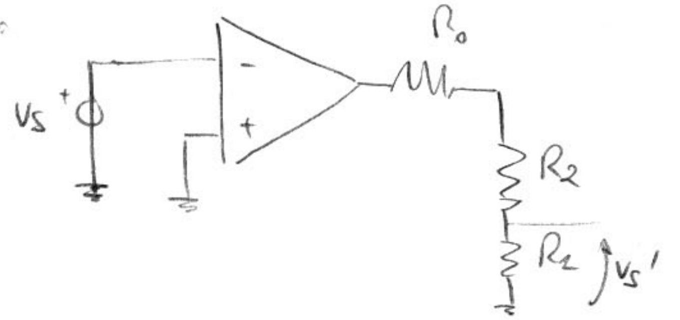
CALCOLO $G_{LOOP}(0)$

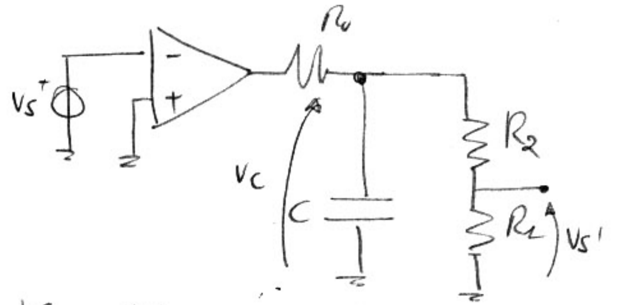


$$\boxed{G_{LOOP}(0)} = -A(0)\frac{R_1}{R_1 + R_2 + R_0} =$$

$$= -10^3 \frac{1k\Omega}{1k\Omega + 12k\Omega + 3k\Omega} = \boxed{-62{,}5}$$

$$\Rightarrow \left|\frac{1}{G_{LOOP}}\right| = 0{,}016 = \boxed{1{,}6\%}$$

(C)



per $f=0$, C aperto

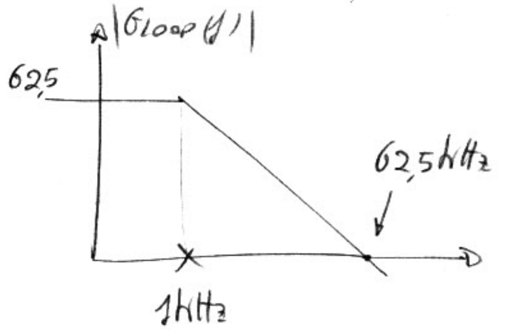
$$G_{loop}(0) = -A_0 \frac{R_1}{R_1+R_2+R_0} = -62{,}5$$

per $f=\infty$, C corto

$$G_{loop}(\infty) = 0$$

$$\tau = C\left[R_0 // (R_1+R_2)\right] = 158{,}4\ \mu s$$

$$\Rightarrow f_0 = \frac{1}{2\pi\tau} = 1\,kHz$$

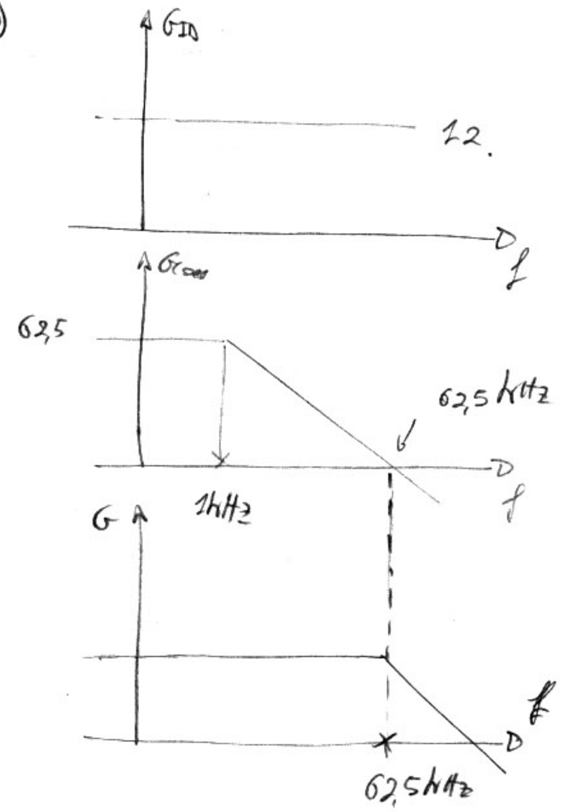


METODO 2

$$\begin{cases} V_c = -A_0 \dfrac{1/sC // (R_2+R_1)}{\left[1/sC // (R_2+R_1)\right] + R_0} V_s \\ V_s' = V_c \dfrac{R_1}{R_1+R_2} \end{cases}$$

$$\Rightarrow \dots \Rightarrow G_{loop}(s) = \frac{-A_0 R_1}{R_1+R_2+R_0} \frac{1}{(1+s\tau)}$$

(D)



La banda del sistema è maggiore di 1 kHz (circa pari a 62,5 kHz).

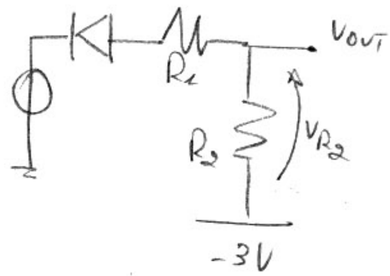
ESERCIZIO 2

(A) D ON se $V_{IN} < -3{,}7V$

se D OFF: $i = 0 \to V_{R2} = 0 \to V_{OUT} = -3V$

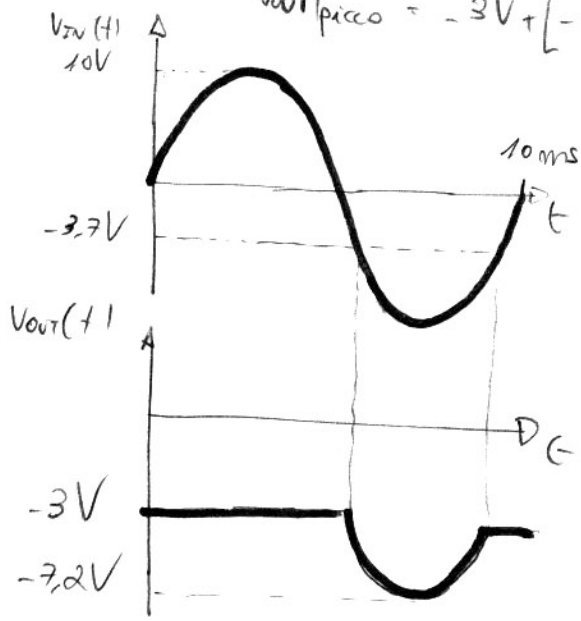
se D ON:

$$V_{R2} = [V_{IN} - (-3V) + 0{,}7V] \frac{R_2}{R_1 + R_2}$$



$$V_{OUT} = -3V + V_{R2}$$

$$V_{OUT}|_{picco} = -3V + [-10V + 3V + 0{,}7V] \frac{4k\Omega}{6k\Omega} = -7{,}2V$$



(B) D2 ON se $V_{OUT} \geq -3V + 0{,}7V = -2{,}3V$

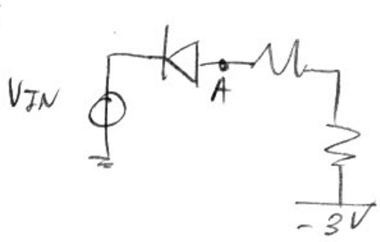
Dal grafico di cui al punto (A), V_{OUT} è sempre $\leq -3V \to$ D2 sempre OFF $\to$ l'andamento della tensione di uscita non cambia

(C) D2

$$V_{INVERSA}|_{MAX} = 7{,}2V - 3V = 4{,}2V$$

D2 non dissipa potenza perchè sempre spento ($\to i = 0$)

D1



Quando D_1 è spento:

$V_A = -3V$

Quindi

$$V_{INVERSA}\big|_{MAX} = V_{IN}\big|_{MAX} - (-3V) = 10V + 3V = 13V$$

Il diodo dissipa potenza quando è acceso (quindi $i \neq 0$):

$$P_{DISS} = V \cdot i = 0{,}7V \times i$$

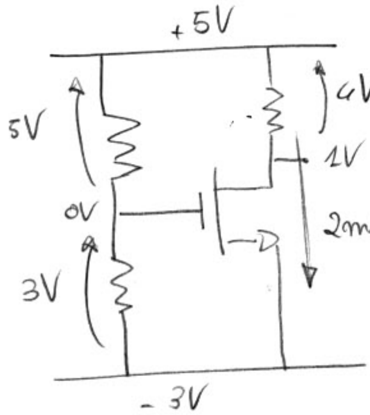
Quindi:

$$P_{DISS}\big|_{MAX} = 0{,}7V \times i_{MAX} = 0{,}7V \times \frac{10V - 3V - 0{,}7V}{(R_1 + R_2)}$$

$$= 0{,}7V \times \frac{6{,}3V}{6k\Omega} = 0{,}735\,mW$$

ESERCIZIO 3

(A)



$V_G = -3V + 3V = 0V$

$V_{OUT} = 5V - 4V = +1V$

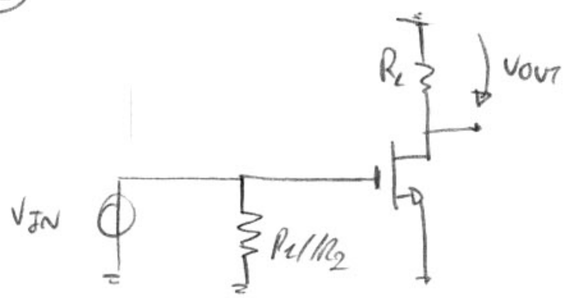
VERIFICA SATURAZIONE:

$V_D \overset{?}{>} V_G - V_T \Rightarrow$

$1V > 0V - 1V \rightarrow$ OK!

$g_m = \frac{2 \times 2mA}{2V} = \frac{2mA}{V}$

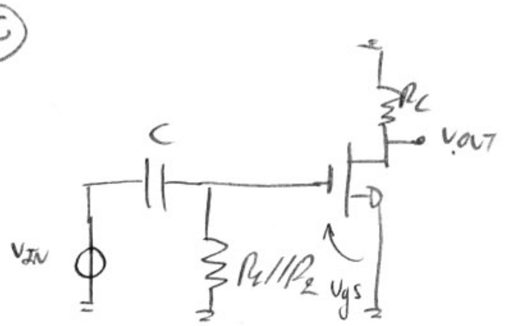
(B)



STADIO SOURCE A MASSA.

$\boxed{G} = -g_m R_L = \frac{2mA}{V} \times 2k\Omega = \boxed{-4}$

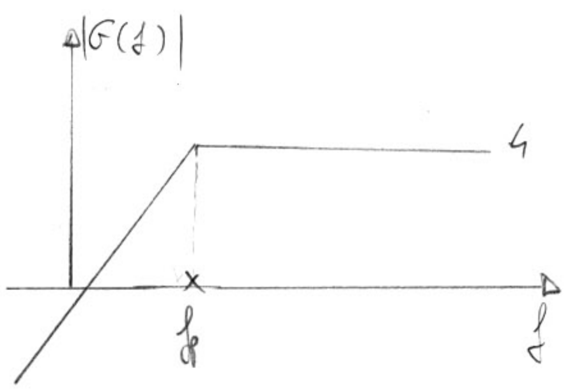
(C)



per $f=0$, C aperto, $\rightarrow G(0) = 0$

per $f \rightarrow \infty$, C corto, $\rightarrow G(\infty) = -g_m R_L = -4$

$\tau = C(R_1//R_2) \rightarrow f_p = \frac{1}{2\pi C(R_1//R_2)}$



Per amplificare segnali con freq superiori ai 20Hz, deve essere

$f_p \leq 20Hz$

⇓

$\boxed{C >} \frac{1}{2\pi (R_1//R_2) f_p} = \boxed{1,4 \mu F}$

Volendo posizionare il polo una decade prima di 20Hz (cioè a 2Hz), si può scegliere $\boxed{C = 14 \mu F}$

METODO 2

$$\begin{cases} v_{OUT} = -R_L\, i_d = -R_L\, g_m\, v_{gs} \\ v_{gs} = v_{IN}\, \dfrac{R_1 // R_2}{R_1 // R_2 + \frac{1}{sC}} \end{cases} \iff \dots \iff$$

$$G(s) = -\frac{g_m R_L\, sC(R_1 // R_2)}{1 + sC(R_1 // R_2)}$$

Esercizio 4

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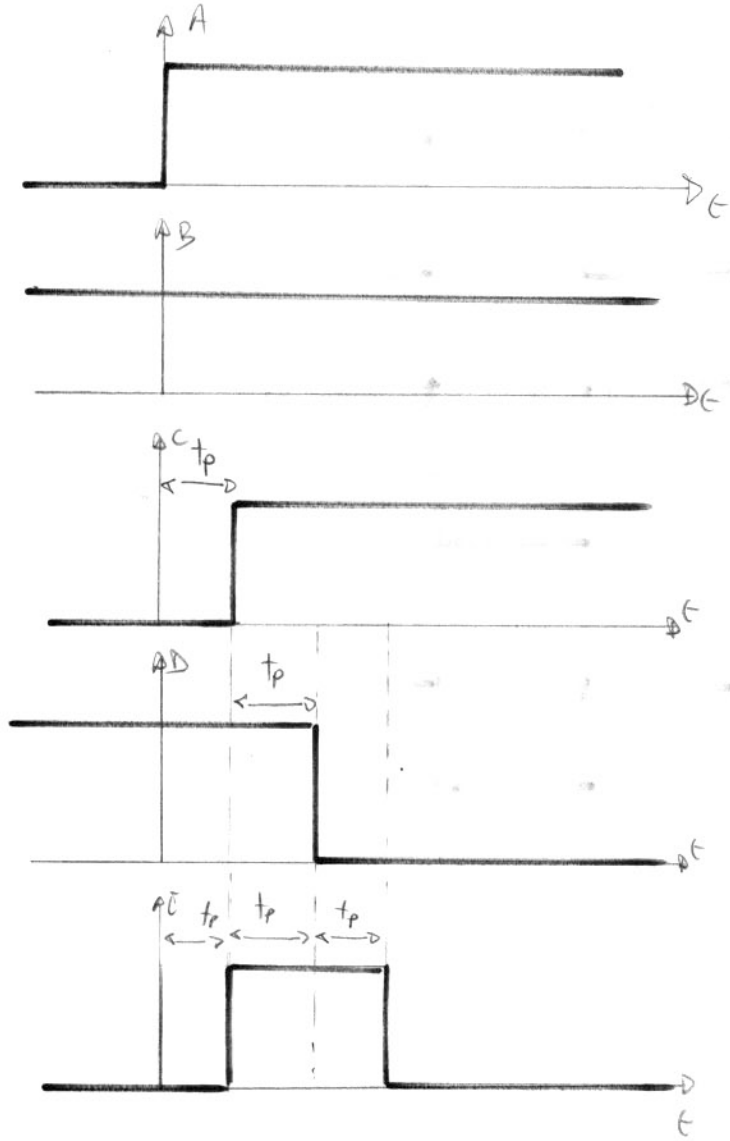
A \ B	0	1
0	0	0
1	1	0

Ⓑ



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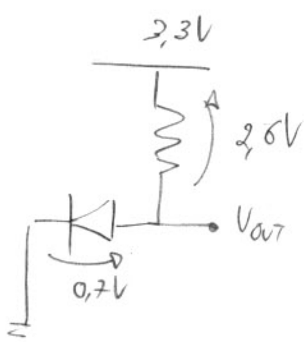
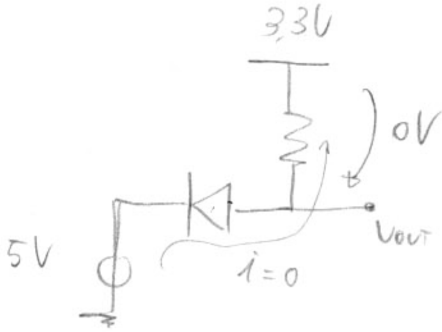
* Quando $E = 0$:



D ON → $V_{OUT} = 0\,V$

(*) Quando $\bar{C} = 1$



D OFF → i = 0 → V_{OUT} = 3,3V