1) Per amplificare correttamente un segnale bipolare in ingresso, poiché l' è alimentato tra 0 e +10V, devo traslare il valore in DC dell'uscita a metà dinamica

⇓

$$V_{out}\Big|_{DC} = 5V = +10V * \left[\frac{R_b}{R_a+R_b}\right] * \left(1+\frac{R_2}{R_1}\right)$$

⇓

$$\frac{R_b}{R_a+R_b} = \frac{1}{1+R_a/R_b} = \frac{5V}{10V}\cdot\frac{1}{1+R_2/R_1} = \frac{1}{2}\cdot\frac{1}{1+10} = \frac{1}{22}$$

↳ $1+\frac{R_a}{R_b} = 22 \rightarrow \frac{R_a}{R_b} = 21$

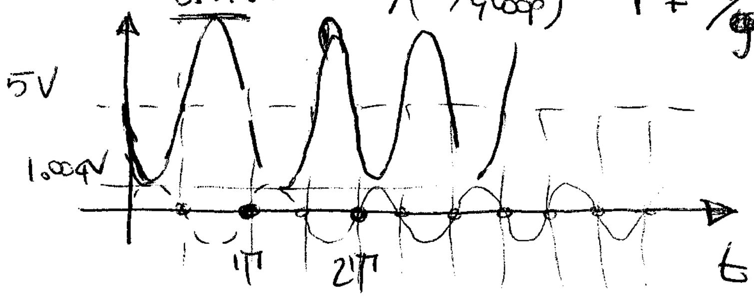
Inoltre per avere $I_{div} \geq 100\mu A \Rightarrow R_a+R_b \leq \frac{+10V}{I_{div}} = \frac{10V}{100\mu A} = 100$

↳ ad esempio $R_b = 5k$ e $R_a = 21 * 5k = 105k \Rightarrow R_a+R_b = 110k$

② $G_{id} = -\frac{R_2}{R_1} = -10$

$$G_{loop} = -\frac{R_1}{R_1+R_2} * A_0 = -\frac{2.2k}{2.2k+22k} * 10^4 \cong -909$$

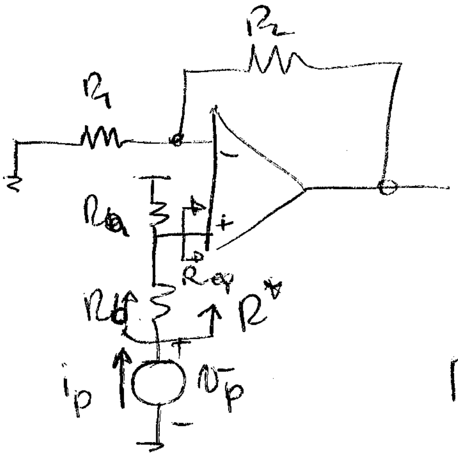
↳ $G_{rede} = G_{id}/\left(1-1/G_{loop}\right) = \frac{-10}{1+1/909} = -9.99$



$$T = \frac{2\pi}{\omega} = \frac{2\pi}{1\,krad/s} = 6.28\,ms$$

$$\Delta V_{out}\Big|_{max} = \left|400\,mV * (-9.99)\right| = 3.996$$

③



$$R^*_{id} = R_b + R_a // \infty$$

⇓

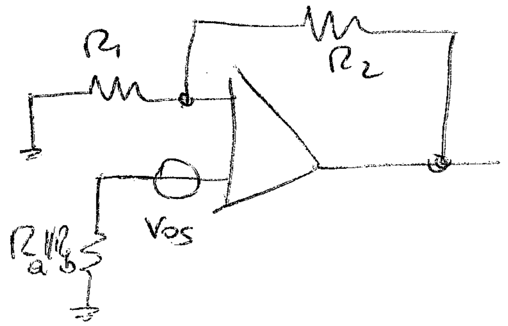
$$R^* = R_b + \left[R_a // \left(R_{eq}\right)\right]$$

$$R_{eq} = R^0_{eq}\left(1-G^*_{loop}\right) = 4.55\,G\Omega$$

$$R^0_{eq} = R_{i0} + R_1//R_2 = 5M\Omega + \overbrace{2.2k//22k}^{2k} = 5.002\,M\Omega$$

$$G^*_{loop} = -\frac{R_1//R_{i0}}{R_1//R_{i0}+R_2}A_0 = -909.1$$

4



$$V_{out}\Big|_{os} = \pm V_{os}\left(1+\frac{R_2}{R_1}\right) = \pm 10\,mV\left(1+\frac{22k}{2.2k}\right.$$

$$= \pm 110\,mV$$

Si è ancora possibile amplificare "correttamente" il segnal[e] di cui al punto (1) perchè la tensione di offset trasla il valor medio della tensione di uscita al più di ± 110

5) Per compensare le correnti di bias la resistenza vist[a] in DC dal morsetto non invertente deve uguagliar[e] quello visto dal morsetto invertente:

$$R_1 \| R_2 = R_a \| R_b$$

$$2k \Rightarrow R_a \| R_b = 2k \quad \text{ed inoltre per i requisiti}$$

punto (1) $\frac{R_a}{R_b} = 21 \Rightarrow \begin{cases} \frac{R_a \cdot R_b}{R_a + R_b} = 2k\Omega \\ \frac{R_a}{R_b} = 21 \end{cases} \Rightarrow \frac{21 R_b^{\cancel{2}}}{22 \cancel{R_b}} = 2k$

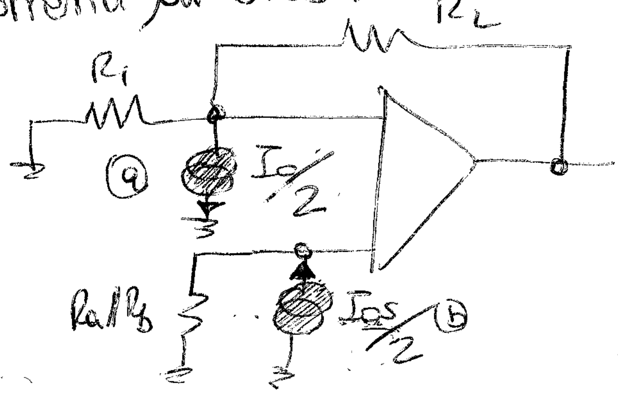
$$\Downarrow$$

$$R_b = 2.1\,k\Omega$$

$$R_a = 44\,k\Omega$$

$$I_{div} = \frac{10V}{R_a + R_b} = 217\,\mu A$$

A questo punto resta solo l'effetto dell'offset delle correnti di bias:



(a) $V_{out} = \frac{\pm I_{os}}{2} * R_2 = \frac{100\,mA * 22k}{2} = \pm 1.1\,mV$

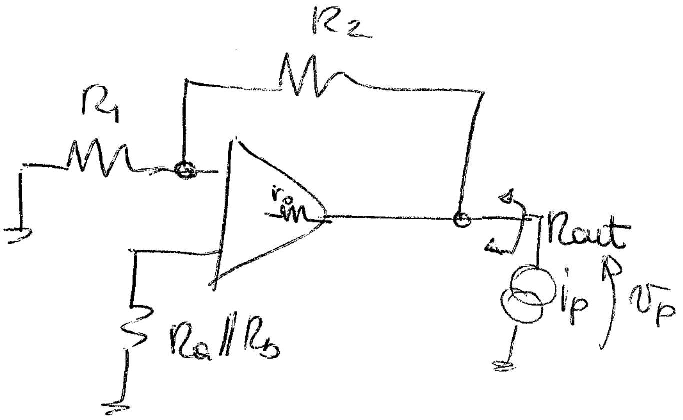
(b) $= \frac{I_{os}}{2}(R_a \| R_b)\left(1+\frac{R_2}{R_1}\right) =$

$\frac{\pm 100\,mA}{2}(2k)(1+10) = \pm 1.1\,m$

$$\Downarrow$$

$$V_o\Big|_{I_{os}} = \pm 2.2\,mV$$

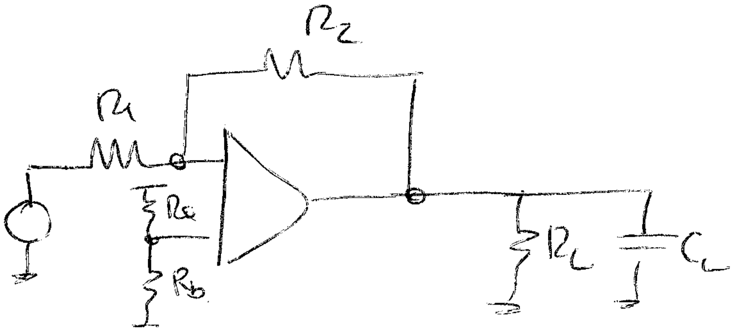
(6)

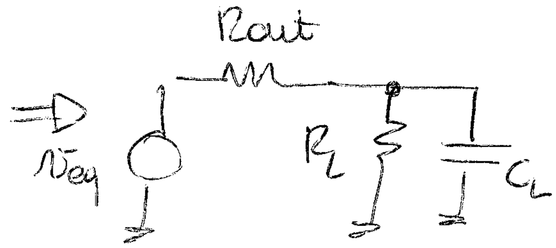


$$R_{out} = \frac{R_{out}^{\circ}}{1 - G_{loop}^{**}} = \frac{r_o \,//\, (R_1 + R_2)}{1 + 907} \simeq \frac{47}{908} = 0.0$$

$$G_{loop}^{**} = -\frac{R_1}{R_1 + R_2 + r_o} A_o = -\frac{2.2k}{2.2k + 22k + 47\Omega} * 10^4 = -907$$

(7)





$$\tau_p = C_L * (R_L // R_{out}) = 200pF * (10k // 0.052\Omega) = 10$$

$$f_p = \frac{1}{2\pi \tau_p} = 15.3\ GHz\ !!$$ la capacità C_L quasi pesa!