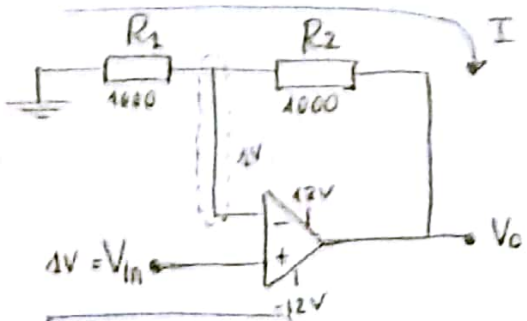
## APARTADO A




$$\begin{cases} I = \dfrac{0 - V_i}{R_1} \\ I = \dfrac{V_i - V_o}{R_2} \end{cases} \rightarrow \frac{-V_i}{R_1} = \frac{V_i - V_o}{R_2} \Rightarrow$$

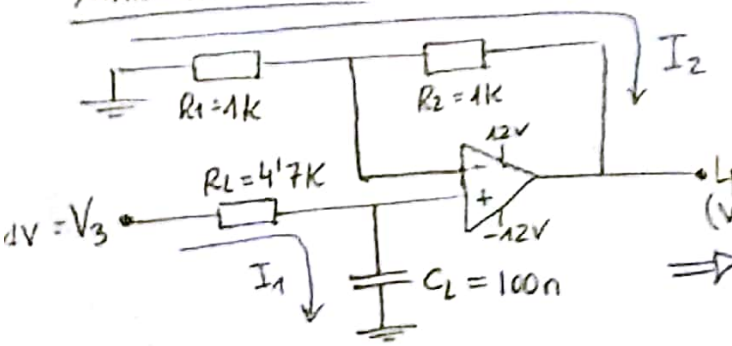
$$\Rightarrow -R_2 V_i = R_1 V_i - R_1 V_o \Rightarrow R_1 V_o = V_i (R_1 + R_2) \Rightarrow$$

$$\Rightarrow \boxed{\frac{V_o}{V_i} = \frac{R_1 + R_2}{R_1}} \qquad |A_v| = \left|\frac{V_o}{V_i}\right| = \frac{R_1 + R_2}{R_1}$$

$$\boxed{|A_v|_{dB} = 20 \log_{10}(2) \simeq 6'021 \text{ dB}}$$

$$\boxed{\varphi = 0^\circ}$$

## APARTADO B.1




$$\begin{cases} I_1 = \dfrac{V_3 - V_+}{R_L} \\ I_1 = \dfrac{V_+ - 0}{Z_{CL}} \end{cases} \Rightarrow \frac{V_3 - V_+}{R_L} = \frac{V_+}{Z_{CL}} \Rightarrow$$

$$\Rightarrow Z_{CL} V_3 = R_L V_+ + Z_{CL} V_+ \Rightarrow V_+ = \frac{Z_{CL} V_3}{R_L + Z_{CL}}$$

$$\begin{cases} I_2 = \dfrac{-V_+}{R_1} \\ I_2 = \dfrac{V_+ - V_o}{R_2} \end{cases} \Rightarrow \frac{-V_+}{R_1} = \frac{V_+ - V_o}{R_2} \Rightarrow -R_2 V_+ = R_1 V_+ - R_1 V_o \Rightarrow R_1 V_o = V_+ (R_1 + R_2) \Rightarrow$$

$$\Rightarrow R_1 V_o = \frac{Z_{CL} \cdot V_3}{R_L + Z_{CL}} (R_1 + R_2) \Rightarrow \frac{V_o}{V_3} = \frac{\frac{1}{j\omega C}(R_1 + R_2)}{R_1 R_L + \frac{R_1}{j\omega C}} \Rightarrow$$

$$\Rightarrow \frac{V_o}{V_i} = \frac{R_1 + R_2}{R_1 + j\omega C (R_1 R_L)} \Rightarrow \boxed{\frac{V_o}{V_i} = \frac{R_1 + R_2}{R_1} \cdot \frac{1}{1 + j\omega C R_L}}$$

$$|A_v| = \frac{R_1 + R_2}{R_1} \cdot \frac{1}{\sqrt{1 + (\omega C R_L)^2}} \quad ; \quad \boxed{|A_v|_{dB} = 20 \log_{10}\left(\frac{R_1 + R_2}{R_1}\right) - 20 \log_{10}\left(\sqrt{1 + (\omega C R_L)^2}\right)}$$

$$|A_v|_{dB} \xrightarrow[\omega \to 0]{} 6'021 \text{ dB} \qquad |A_v|_{dB} \xrightarrow[\omega \to \infty]{} -\infty$$

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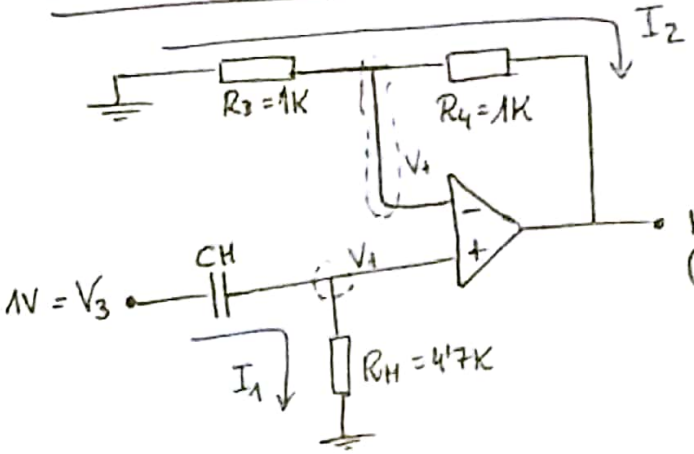
$$\boxed{\varphi = -\text{arctg}(\omega C R_L)} \quad ; \quad \varphi \xrightarrow[\omega \to 0]{} 0^\circ \quad ; \quad \varphi \xrightarrow[\omega \to \infty]{} -\frac{\pi}{2}$$

$$\omega_0 = (C R_L)^{-1}$$

$$\boxed{f_0 = (2\pi C R_L)^{-1} = 338'63 \text{ Hz}}$$

## APARTADO B.2




$$\begin{cases} I_1 = \dfrac{V_3 - V_+}{Z_C} \\ I_1 = \dfrac{V_+ - 0}{R_H} \end{cases} \Rightarrow \frac{V_3 - V_+}{Z_C} = \frac{V_+}{R_H} \Rightarrow$$

$$\Rightarrow R_H V_3 - R_H V_+ = V_+ Z_C \Rightarrow V_+ = \frac{R_H V_3}{Z_C + R_H}$$

$$\begin{cases} I_2 = \dfrac{-V_+}{R_3} \\ I_2 = \dfrac{V_+ - V_o}{R_4} \end{cases} \Rightarrow \frac{-V_+}{R_3} = \frac{V_+ - V_o}{R_4} \Rightarrow -R_4 V_+ = R_3 V_+ - R_3 V_o \Rightarrow$$

$$\Rightarrow R_3 V_o = V_+ (R_3 + R_4) \Rightarrow R_3 V_o = \frac{R_H V_3}{Z_C + R_H}(R_3 + R_4) \Rightarrow$$

$$\Rightarrow \frac{V_o}{V_i} = \frac{R_3 R_H + R_4 R_H}{Z_C R_3 + R_H R_3} = \frac{R_3 R_H + R_4 R_H}{\frac{R_3}{j\omega C} + R_H R_3} = \frac{(R_3 R_H + R_4 R_H) j\omega C}{R_3 + j\omega C (R_H R_3)} \Rightarrow$$

$$\Rightarrow \boxed{\frac{V_o}{V_i} = \frac{R_3 R_H + R_4 R_H}{R_3} \cdot \frac{j\omega C}{1 + j\omega C R_H}}$$

$$|A_V| = \left|\frac{V_o}{V_i}\right| = \frac{R_3 R_H + R_4 R_H}{R_3} \cdot \frac{\omega C}{\sqrt{1 + (\omega C R_H)^2}}$$

$$\boxed{|A_V|_{dB} = 20 \cdot \log_{10}\left(\frac{R_3 R_H + R_4 R_H}{R_3}\right) + 20 \cdot \log_{10}(\omega \cdot C) + 20 \cdot \log_{10}\left(\sqrt{1 + (\omega C R_H)^2}\right)}$$

$$|A_V|_{dB} \xrightarrow[\omega \to 0]{} -\infty \quad ; \quad |A_V|_{dB} \xrightarrow[\omega \to \infty]{} 6'021\ dB$$

$$\boxed{\varphi = \frac{\pi}{2} - \text{arctg}(\omega C \cdot R_H)} \quad ; \quad \varphi \xrightarrow[\omega \to 0]{} \frac{\pi}{2} \quad ; \quad \varphi \xrightarrow[\omega \to \infty]{} 0^\circ$$

$$\omega_0 = (C R_H)^{-1}$$

$$\boxed{f_0 = (2\pi C R_H)^{-1} = 3386'28\ Hz}$$