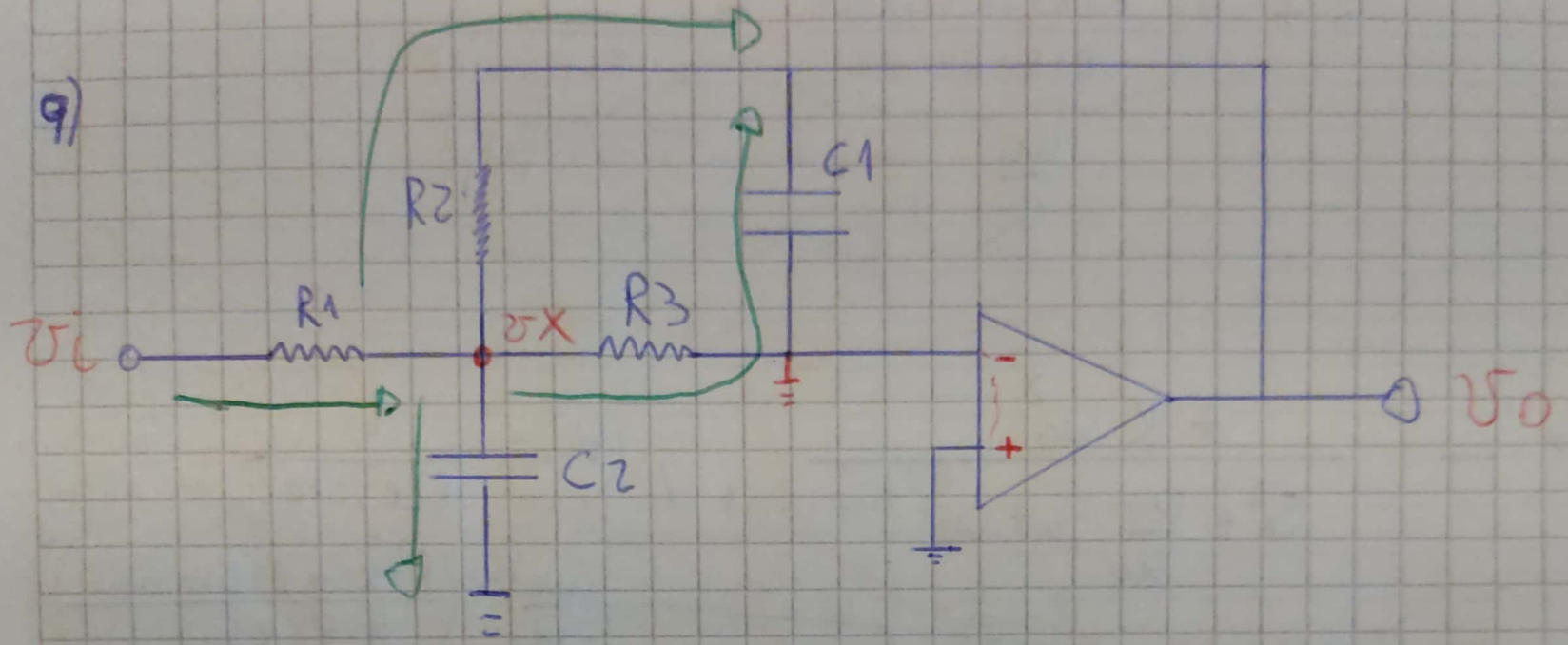
9)



$$v_X\left(\frac{1}{R_1}+\frac{1}{R_2}+sC_2+\frac{1}{R_3}\right)-\frac{1}{R_1}v_i-\frac{1}{R_2}v_o=0 \quad (1)$$

$$\frac{1}{R_3}v_X=-sC_1v_o \Rightarrow v_X=-sC_1R_3v_o \quad (2)$$

NOTA

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② en ①

$$-(sC_1 R_3 v_o)\frac{R_2R_3 + R_1R_2 + R_3R_1 + sR_1R_2R_3C_2}{R_1R_2R_3} - \frac{1}{R_2}v_o = \frac{1}{R_1}v_i$$

$$-\frac{[s^2 R_1R_2R_3C_1C_2 + sC_1(R_1R_2 + R_1R_3 + R_2R_3) + R_1]}{R_1R_2}v_o = \frac{1}{R_1}v_i$$

$$T(s) = \frac{-R_2}{s^2 R_1R_2R_3C_1C_2 + sC_1(R_1R_2 + R_1R_3 + R_2R_3) + R_1}$$

$$T(s) = -\frac{\frac{1}{R_1R_3C_1C_2}\cdot\frac{R_2}{R_2}}{s^2 + s\left(\frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1R_2R_3C_2}\right) + \left(\frac{1}{R_2R_3C_1C_2}\right)}$$

$\frac{1}{R_1R_3C_1C_2}\cdot\frac{R_2}{R_2} = \omega_0^2 \cdot K$; $\frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1R_2R_3C_2} = \frac{\omega_0}{Q}$; $\frac{1}{R_2R_3C_1C_2} = \omega_0^2$

$$T(s) = -\frac{+K\omega_0^2}{s^2 + \frac{\omega_0}{Q_0}s + \omega_0^2}$$

$$\omega_0^2 = \frac{1}{R_1R_3C_1C_2}$$

$$\left(\frac{\omega_0}{Q}\right)^2 = \left(\frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1R_2R_3C_2}\right)^2$$

$$\frac{1}{R_2R_3C_1C_2} = \frac{(R_1R_2 + R_2R_3 + R_1R_3)^2}{R_1^2R_2^2R_3^2C_2^2}\cdot Q^2 \quad ; \quad K = R_2/R_1$$

$$Q^2 = \frac{C_2R_1^2R_2R_3}{C_1(R_1 + R_2 + R_2R_3 + R_1R_3)^2} \rightarrow Q = \frac{R_1\sqrt{R_2R_3C_2}}{\sqrt{C_1}(R_1R_2 + R_2R_3 + R_1R_3)}$$

NOTA

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$R1 = R2 = R3 = 1\Omega$; $C1 = 0,01F$; $C2 = 1F$

$$w_0^2 = \frac{1}{1\Omega \cdot 1\Omega \cdot 1F \cdot 0,01F} \Rightarrow w_0^2 = 100\,s^{-2}$$

$$w_0 = 10\,s^{-1}$$

$$Q = \frac{1\Omega \cdot \sqrt{1\Omega^2 \cdot 1F}}{\sqrt{0,01F}(1\Omega \cdot 1\Omega \cdot 3)} = 3,33 \quad ; \quad K = 1$$

$$T(S) = -\frac{K\,w_0^2}{S^2 + \frac{w_0}{Q}S + w_0^2}$$

$$T(S) = -\frac{100\,seg^{-2}}{S^2 + 3S + 100\,seg^{-1}}$$

$$T(w) = T(S)\Big|_{S=jw} = -\frac{100\,seg^{-1}}{(100\,seg^{-1} - w^2) + jw.3}$$

$$|T(w)| = \frac{100\,seg^{-1}}{\sqrt{(100\,seg^{-1} - w^2)^2 + (w3)^2}}$$

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b)

Normalizamos:

$\omega_0 = 1 \Rightarrow \omega_0^2 = 1 = \frac{1}{R_2 R_3 C_1 C_2} \Rightarrow R_2 R_3 C_1 C_2 = 1$; $C_{2N} = \frac{1}{C_{1N}}$

$R_1 = R_2 = R_3 = 1$

$K_{dB} = 10{,}6\,dB \rightarrow$ GRÁFICO ; $\underset{4700pF}{C_1} = C_{1N} / (\underset{1000}{\Omega_{\omega_0}} \cdot \Omega_Z)$

$K = \frac{R_2}{R_1}$

$\underset{47pF}{C_2} = C_{2N} / \left(\frac{\Omega_{\omega_0}}{1000} \cdot \Omega_Z \right)$

$C_1 = \frac{1}{C_{2N}} / (\Omega_{\omega_0} \cdot \Omega_Z)$; $C_{2N} = C_2 \Omega_{\omega_0} \cdot \Omega_Z$

$C_{2N} \cdot C_1 = \frac{1}{\Omega_{\omega_0} \cdot \Omega_Z}$; $C_1 C_2 \Omega_{\omega_0} \cdot \Omega_Z = \frac{1}{\Omega_{\omega_0} \cdot \Omega_Z}$

$$\Omega_Z^2 = \frac{1}{\Omega_{\omega_0}^2 \cdot C_1 C_2}$$

$\Omega_Z = 2{,}13\,M\Omega \rightarrow R_1 = R_2 = R_3 = 1 \cdot \Omega_Z = 2{,}13\,M\Omega$

NOTA

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