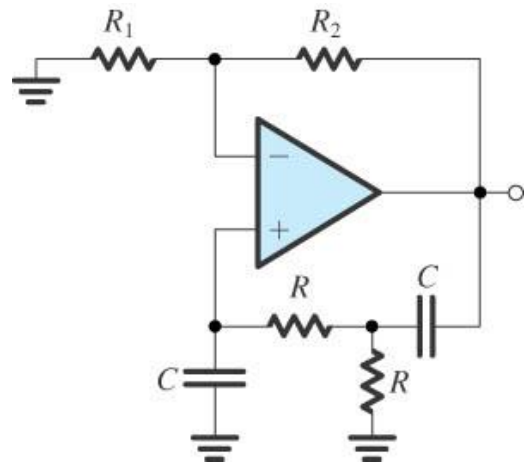
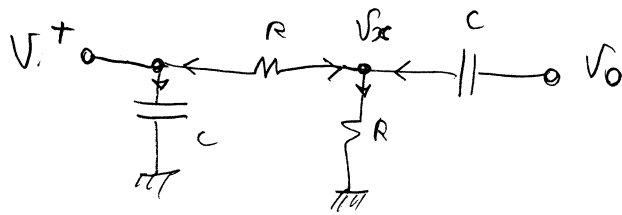


Problema**Osciladores 1 – Oscilador RC sinusoidal com amplificador operacional**

Considere o circuito da figura. Determine $A\beta(s)$, $A\beta(j\omega)$, a frequência de oscilação e qual o valor mínimo do ganho para que o circuito oscile.



Osciladores 1



$$\beta(\lambda) = \frac{V^+(\lambda)}{V_0(\lambda)}$$

$$\begin{cases} \frac{V^+}{\frac{1}{\lambda C}} = \frac{V_{xc} - V^+}{R} \\ \frac{V^+ - V_{xc}}{R} + \frac{V_0 - V_{xc}}{\frac{1}{\lambda C}} = \frac{V_{xc}}{R} \end{cases} \quad \begin{cases} V_{xc} = V^+ (1 - \lambda R C) \\ V^+ - V_{xc} + \lambda R C V_0 - \lambda R C V_{xc} = V_{xc} \end{cases}$$

$$\beta = \frac{V^+}{V_0} = \frac{\frac{\lambda}{R C}}{\lambda^2 + \frac{3}{R C} \lambda + \frac{1}{R^2 C^2}}$$

$$A = \frac{V_0}{V^+} = 1 + \frac{R_2}{R_1}$$

$$A\beta(\lambda) = \frac{\left(1 + \frac{R_2}{R_1}\right) \frac{\lambda}{R C}}{\lambda^2 + \frac{3}{R C} \lambda + \frac{1}{R^2 C^2}}$$

$$A\beta(j\omega) = \frac{\left(1 + \frac{R_2}{R_1}\right) \frac{j\omega_0}{R C}}{-\omega_0^2 + 3j\frac{\omega_0}{R C} + \frac{1}{R^2 C^2}}$$

$$A\beta = 1 \Rightarrow \begin{cases} \text{Im}\{A\beta\} = 0 \Rightarrow \omega_0^2 = \frac{1}{R^2 C^2} \\ \text{Re}\{A\beta\} = 1 \Rightarrow 1 + \frac{R_2}{R_1} = 3 \end{cases}$$

$$\boxed{\omega_0 = \frac{1}{R C}}$$

$$\boxed{A_{min} = 3}$$

$$\left(\frac{R_2}{R_1}\right)_{min} = 2$$