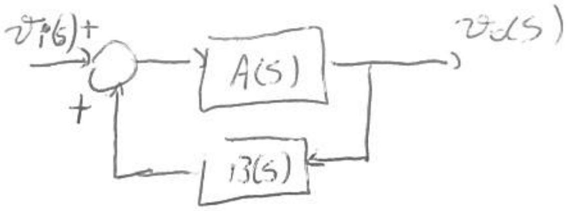
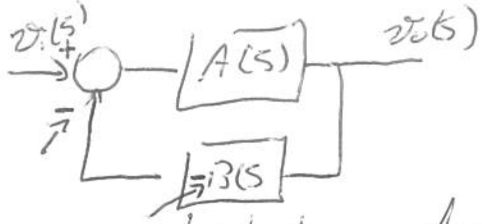
Aula 13B - 2016

- Oscilador de deslocamento de fase

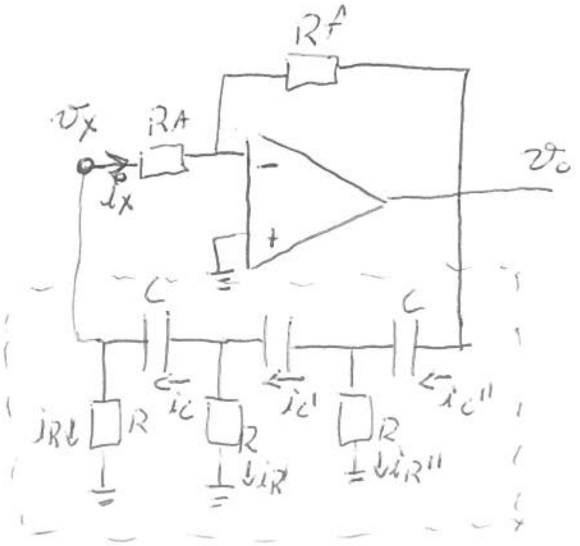
obs: Realimentação Positiva



OU



↳ deslocou a fase em 180°



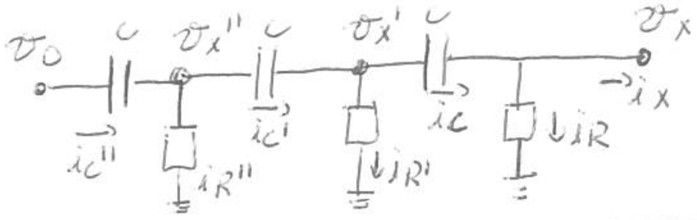
- $$\underbrace{\frac{v_x - 0}{RA}}_{i_x} = \frac{0 - v_o}{RF} \Rightarrow \boxed{\frac{v_o}{v_x} = -\frac{RF}{RA}} \rightsquigarrow A(s)$$

FALTA DETERMINAR B(S)

$$B(s) = \frac{v_x(s)}{v_o(s)}$$

obs. $A(s) = \frac{v_o}{v_x}$; $B(s) = \frac{v_x}{v_o} \Rightarrow L(s) = \underbrace{\frac{v_o}{v_x}}_{A} \cdot \underbrace{\frac{v_x}{v_o}}_{B} \Rightarrow L(s) = 1$

↳ condição de oscilação



- Assumindo $i_x \ll i_R \Rightarrow \boxed{R_A \gg R}$

- $v_x' = v_x + \frac{i_c}{sC} \Rightarrow v_x' = \frac{i_R}{sC} + v_x \Rightarrow v_x' = v_x + \frac{v_x}{R}\cdot\frac{1}{sC} \Rightarrow \boxed{v_x' = v_x\left(1+\frac{1}{RsC}\right)}$

- $v_x'' = v_x' + \frac{i_c'}{sC} \Rightarrow v_x'' = v_x\left(1+\frac{1}{sRC}\right) + \frac{1}{sC}\left(\frac{v_x'}{R} + i_c\right) \Rightarrow v_x'' = v_x\left(1+\frac{1}{sRC}\right)+\frac{1}{sC}\left[\frac{v_x}{R}\left(1+\frac{1}{RCs}\right)+\frac{v_x}{R}\right.$

$$v_x'' = v_x\left\{\underbrace{\left(1+\frac{1}{RCs}\right)}_{\frac{RCs+1}{RCs}} + \frac{1}{RCs}\cdot\underbrace{\left[\underbrace{\left(1+\frac{1}{RCs}\right)}_{\frac{RCs+1}{RCs}}+1\right]}_{\frac{2RCs+1}{RCs}}\right\} \Rightarrow v_x'' = v_x\left\{\frac{RCs+1}{RCs}+\frac{2RCs+1}{(RC)^2s^2}\right\}$$

$$v_x'' = v_x\,\frac{(RC)^2s^2+RCs+2RCs+1}{(RC)^2s^2}$$

- $v_x'' = v_x\,\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2}$

- $v_0 = v_x'' + \frac{i_c''}{sC} \Rightarrow v_0 = v_x\,\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2} + \frac{1}{sC}\cdot\left(\frac{v_x''}{R}+i_c'\right)$

$$i_c' = i_c + i_R' = \frac{v_x}{R}+\frac{v_x'}{R} = \frac{v_x}{R}+\frac{1}{R}\cdot v_x\left(\frac{RCs+1}{RCs}\right) = \frac{v_x}{R}\cdot\left(1+\frac{RCs+1}{RCs}\right)$$

$$\boxed{i_c' = \frac{v_x}{R}\cdot\left(\frac{2RCs+1}{RCs}\right)}$$

$$\rightarrow v_0 = v_x\,\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2} + \frac{1}{sC}\cdot\left[\overbrace{\frac{v_x}{R}\left(\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2}\right)}^{\frac{v_x''}{R}} + \overbrace{\frac{v_x}{R}\left(\frac{2RCs+1}{RCs}\right)}^{i_c'}\right]$$

$$v_0 = v_x\left\{\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2}+\frac{1}{RCs}\cdot\left[\frac{(RC)^2s^2+3(RC)s+1+2(RC)^2s^2+(RC)s}{(RC)^2s^2}\right]\right\}$$

$$v_0 = v_x\cdot\left\{\frac{(RC)^2s^2+3RCs+1}{(RC)^2s^2} + \frac{3(RC)^2s^2+4RCs+1}{(RC)^3s^3}\right\}$$

$$v_0 = v_x\cdot\left\{\frac{(RC)^3s^3+3(RC)^2s^2+RCs+3(RC)^2s^2+4RCs+1}{(RC)^3s^3}\right\}$$

$$\boxed{\frac{v_x}{v_0} = \frac{(RC)^3s^3}{(RC)^3s^3+6(RC)^2s^2+5RCs+1}} \rightarrow B(s)$$

$$L(s) = A(s) \cdot B(s) = 1$$

$$L(s) = -\frac{RF}{RA} \cdot \frac{\tau^3 s^3}{\tau^3 s^3 + 6\tau^2 s^2 + 5\tau s + 1} = 1$$

$$\mathcal{L}(j\omega_0) = -\frac{RF}{RA} \cdot \frac{-\tau^3 j \omega_0^3}{-\tau^3 \omega_0^3 j - 6\tau^2\omega_0^2 + 5\tau j \omega_0 + 1} = 1$$

$$\mathcal{L}(j\omega_0) = -\frac{RF}{RA} \cdot \frac{\tau^3 \omega_0}{\tau^3\omega_0^3 - 6\tau^2\omega_0^2 j - 5\tau\omega_0 + j} = 1$$

$$\mathcal{L}(j\omega_0) = -\frac{RF}{RA} \frac{\tau^3 \omega_0^3}{j\left(1 - 6\omega_0^2\tau^2\right) + \left(\omega_0^3\tau^3 - 5\omega_0\tau\right)} = 1$$

- $\angle L(j\omega_0) = -1 \Rightarrow 1 - 6(\omega_0\tau)^2 = 0 \Rightarrow \boxed{\omega_0 = \frac{1}{\tau\sqrt{6}}}$

- $|L(j\omega_0)| = 1 \Rightarrow -\frac{RF}{RA} \frac{\tau^3\omega_0^3}{\omega_0^3\tau^3 - 5\omega_0\tau} = 1$

$$-\frac{RF}{RA} \frac{\tau^3\left(\frac{1}{\tau\sqrt{6}}\right)^3}{\left(\frac{1}{\tau\sqrt{6}}\right)^3\tau^3 - 5\frac{1}{\tau\sqrt{6}}\tau} = 1 \Rightarrow \frac{RF}{RA} \cdot \frac{\frac{1}{6\sqrt{6}}}{\frac{1}{6\sqrt{6}} - \frac{5}{\sqrt{6}}} = 1$$

$$-\frac{Rf}{RA} \frac{\frac{1}{6\sqrt{6}}}{\frac{1-30}{6\sqrt{6}}} = 1 \Rightarrow \boxed{\frac{Rf}{RA} = 29}$$