13.4 SEDRA (5°ed)

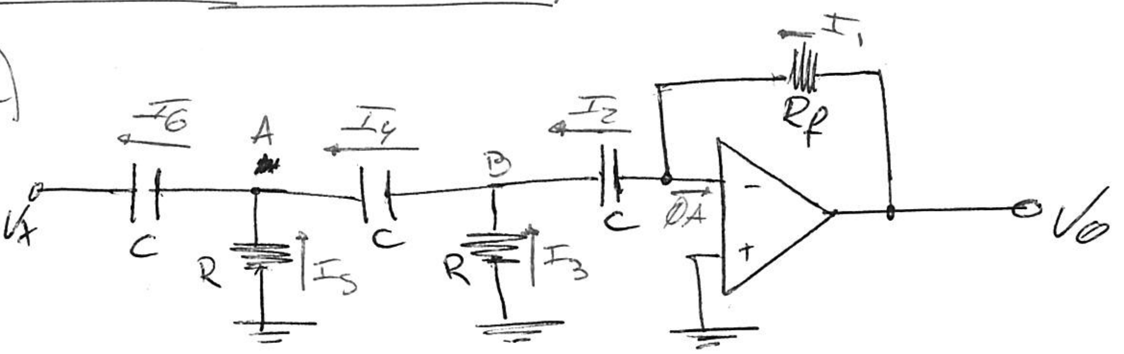
a) $\frac{R_F}{R_A} = 2 \Rightarrow \frac{10+X}{50-X} = 2 \Rightarrow X = 30$

Portando R_A deve ser $(50-30)k\Omega = 20k\Omega$, logo o potenciometro deve ser posicionado em $20k\Omega$ para o terra.

b) $f = \frac{1}{2\pi RC} = \frac{1}{2\pi \cdot 10 \cdot 10^3 \cdot 16 \cdot 10^{-9}} \Rightarrow \boxed{f = 1\,kHz}$

13.5 e 6 sedra (5°ed)

a)



$I_1 = \frac{V_o}{R_f}$

$V_B = 0 - \frac{I_2}{sC} = -\frac{I_1}{sC} \quad (I_2 = I_1) = \frac{-1}{sC}\left(\frac{V_o}{R_f}\right) = \frac{-V_o}{sCR_f}$

- $I_3 = \frac{0 - V_B}{R} = \frac{V_o}{sCR_f}$

- $V_A = V_B - \frac{I_4}{sC} = -\frac{V_o}{sCR_f} - \frac{1}{sC}(I_3 + I_2) = \frac{-V_o}{sCR_f} - \frac{1}{sC}\left(\frac{V_o}{sCR_fR} + \frac{V_o}{R_f}\right)$

- $I_5 = \frac{0 - V_A}{R} = \frac{V_o}{sCR_fR} + \frac{1}{sCR}\left(\frac{V_o}{sCR_fR} + \frac{V_o}{R_f}\right)$

• $I = I_6 = I_5 + I_4 = I_5 + I_3 + I_2 = I_5 + I_3 + I_1$

• Substituindo, temos:

$$I = \frac{V_0}{sCR_fR}\left(2+\frac{1}{sCR}\right) + \frac{V_0}{R_f}\left(1+\frac{1}{sCR}\right)$$

• $V_x = V_A - \frac{I_6}{sC} = V_A - \frac{I}{sC}$

• Substituindo V_A e I, temos:

$$V_x = -\frac{V_0}{sCR_f}\left[3+\frac{4}{sCR}+\frac{1}{s^2C^2R^2}\right] = \boxed{-\frac{V_0}{j\omega CR_f}\left[3+\frac{4}{j\omega CR}-\frac{1}{\omega^2C^2R^2}\right]}$$

•

b.) $$A\beta = \frac{V_0}{V_x} = \frac{-j\omega CR_f}{\left[3+\frac{4}{j\omega CR}-\frac{1}{\omega^2C^2R^2}\right]} = \frac{\omega^2C^2 \cdot R \cdot R_f}{4+j\left(3\omega CR-\frac{1}{\omega CR}\right)}$$

Condições para oscilação:

$|A\beta| = 1$, $\angle A\beta = 0^\circ$ ou 360°

• $$\angle A\beta = 0^\circ \Rightarrow \angle \frac{\omega_0^2C^2R\cdot R_f}{4+j\left(3\omega_0CR-\frac{1}{\omega_0CR}\right)} = 0^\circ \Rightarrow 0^\circ - tg^{-1}\left(\frac{3\omega_0CR-\frac{1}{\omega_0CR}}{4}\right) = 0^\circ$$

$$\Rightarrow 3\omega_0CR - \frac{1}{\omega_0CR} = 0 \Rightarrow \omega_0 = \frac{1}{CR\sqrt{3}} = \frac{1}{16\cdot10^{-9}\cdot10\cdot10^3\cdot\sqrt{3}}$$

$$\Rightarrow \boxed{\omega_0 = 574{,}3\,Hz}$$

c) $|A\beta| \geq 1 \Rightarrow \left| \dfrac{\omega_0^2 \cdot C^2 \cdot R \cdot R_f}{4 + j\left(3\omega_0 CR - \dfrac{1}{\omega_0 CR}\right)} \right| \geq 1$

Substituindo ω_0, temos:

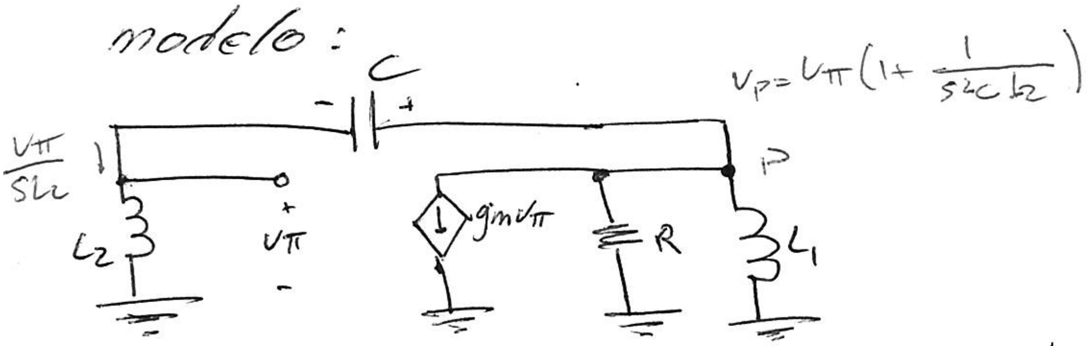
$$\left| \dfrac{\left(\dfrac{1}{CR\sqrt{3}}\right)^2 \cdot C^2 \cdot R \cdot R_f}{4 + j\underbrace{\left(3\left(\dfrac{1}{CR\sqrt{3}}\right)CR - \dfrac{1}{\left(\dfrac{1}{CR\sqrt{3}}\right)CR}\right)}_{0}} \right| \geq 1 \Rightarrow \frac{1}{3}\left(\frac{R_f}{R}\right) \geq 4$$

$\Rightarrow R_f \geq 12R \Rightarrow R_f = 12R \Rightarrow R_f = 12 \cdot 10 \cdot 10^3 \Rightarrow \boxed{R_f = 120k\Omega}$

Portanto, o ponto mínimo é com o potenciômetro em $20k\Omega$

13.8 SEDRA 5ª ed

modelo:



$$V_P = V_\pi + V_C = V_\pi + \frac{1}{sC} \cdot \frac{V_\pi}{sL_2} = V_\pi \left(1 + \frac{1}{s^2 C L_2}\right)$$

Corrente nó P:

$$\frac{V_\pi}{sL_2} + g_m V_\pi + \left(\frac{1}{sL_1} + \frac{1}{R}\right) V_\pi \left(1 + \frac{1}{s^2 C L_2}\right) = \emptyset.$$

- Como $V_\pi \neq 0$, divide por V_π:

$$\frac{1}{sL_2} + g_m + \left(\frac{1}{sL_1} + \frac{1}{R}\right)\left(1 + \frac{1}{s^2 C L_2}\right) = 0$$

- Substituindo $s = j\omega$, temos:

$$\left(g_m + \frac{1}{R} - \frac{1}{\omega^2 R C L_2}\right) + j\left(\frac{1}{\omega^3 C L_1 L_2} - \frac{1}{\omega L_1} - \frac{1}{\omega L_2}\right) = 0$$

- Para oscilação iniciar tanto a parte real como imaginária deve ser zero:

  → fazendo a parte imaginária igual a zero, temos:

$$\boxed{\omega_0 = \sqrt{\frac{1}{(L_1 + L_2)C}}}$$

• Para oscilar, impomos $|A\beta| \geq 1$:

→ Substituindo ω_0 , temos:

$$\left| \left(g_m + \frac{1}{R} - \frac{1}{\omega_0^2 R C L_2} \right) + j \cancelto{0}{\left(\frac{1}{\omega^3 C L_1 L_2} - \frac{1}{\omega L_1} - \frac{1}{\omega L_2} \right)} \right| \geq 1$$

$$g_m + \frac{1}{R} - \frac{C(L_1 + L_2)}{R C L_2} \geq 1$$

$$\therefore \boxed{g_m R \geq \frac{L_1}{L_2}}$$

13.16 (SEDRA 5° ed)

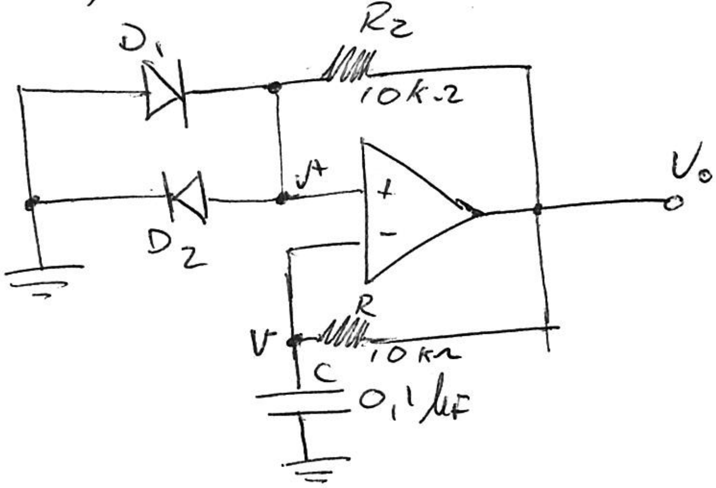
- $T = 2\overset{\tau}{RC} \ln\left(\frac{1+\beta}{1-\beta}\right) \Rightarrow T = 2 \cdot 1 \cdot 10^{6} \cdot 0{,}01 \cdot 10^{-6} \ln\left(\frac{1+0{,}09}{1-0{,}09}\right) = 3{,}6\,ms$

- $\beta = \frac{R_1}{R_1+R_2} = \frac{100k\Omega}{100k\Omega + 1M\Omega} = 0{,}09$

$f = \frac{1}{T} = \frac{1}{3{,}6m} \Rightarrow \boxed{f = 274\,Hz}$

13.17 (SEDRA 5° ed)

- *Circuito modificado:*



- $V^+ = \beta L^+ = V_D \Rightarrow \beta = \frac{V_D}{L^+} = \frac{V_D}{12}$

- $T = 2RC \ln\left(\frac{1+\beta}{1-\beta}\right) = 2 \cdot 10 \cdot 10^{3} \cdot 0{,}1 \cdot 10^{-6} \ln\left(\frac{1+\frac{V_D}{12}}{1-\frac{V_D}{12}}\right)$

$T = 0{,}002 \ln\left(\frac{12+V_D}{12-V_D}\right)$

$f = \frac{1}{T} = \frac{1}{0{,}002 \ln\left(\frac{12+V_D}{12-V_D}\right)} \Rightarrow \boxed{f = \frac{500}{\ln\left(\frac{12+V_D}{12-V_D}\right)}}$

• Considerando que a 25°C, $V_D = 0,7V$ e que V_D cai 2mV a cada 1°C que aumenta:

→ Para 0°C:

$$V_D = 0,7 + -2 \cdot 10^{-3} \cdot (0-25) = 0,75V$$

$$f = \frac{500}{\ln\left(\frac{12+0,75}{12-0,75}\right)} \Rightarrow \boxed{f(0°C) = 3995 Hz}$$

→ Para 25°C:

$$V_D = 0,7 + -2 \cdot 10^{-3}(25-25) = 0,7V$$

$$f = \frac{500}{\ln\left(\frac{12+0,7}{12-0,7}\right)} \Rightarrow \boxed{f_{(25°C)} = 4281 Hz}$$

→ Para 50°C

$$U_D = 0,7 + -2mV(50-25) = 0,65V$$

$$f = \frac{500}{\ln\left(\frac{12+0,65}{12-0,65}\right)} \Rightarrow \boxed{f_{(50°C)} = 4611 Hz}$$

→ Para 100°C

$$V_D = 0,7 + -2mV(100-25) = 0,55V$$

$$f = \frac{500}{\ln\left(\frac{12+0,55}{12-0,55}\right)} \Rightarrow \boxed{f_{(100°C)} = 5451 Hz}$$

13.18 (SEDRA 5°ed)

- $T = \frac{1}{f} = \frac{1}{1 \cdot 10^3} = 1ms$

- $T = T_1 + T_2 = RC\left(\frac{V_{TH} - V_{TL}}{L+}\right) + RC\left(\frac{V_{TH} - V_{TL}}{-L-}\right)$

$L_+ = -L_-$: $T = 2RC\left(\frac{V_{TH} - V_{TL}}{L+}\right)$

- Sendo $V_{PP} = 10V$, $V_{TH} = +5V$ e $V_{TL} = -5V$, temos:
substituindo em T:
$1 \cdot 10^{-3} = 2(0{,}01 \cdot 10^{-6})R\left(\frac{5 + (-5)}{10}\right) \Rightarrow \boxed{R = 50k\Omega}$

- $V_{TH} = -L_-\left(\frac{R_1}{R_2}\right) \Rightarrow 5 = 10 \cdot \left(\frac{10 \cdot 10^3}{R_2}\right) \Rightarrow \boxed{R_2 = 20k\Omega}$