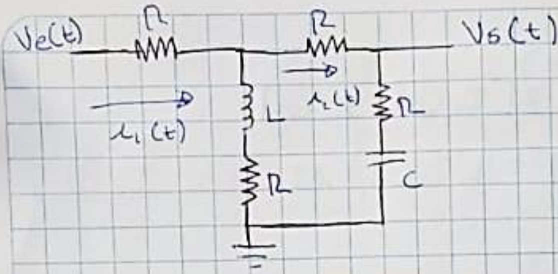


Ecuaciones principales

$$2R\,i_1(t) \qquad R\,i_1(t) - R\,i_2(t)$$

$$V_e(t) = R\,i_1(t) + L\frac{d\,[i_1(t) - i_2(t)]}{dt} + R\,[i_1(t) - i_2(t)]$$

$$L\frac{d\,[i_1(t) - i_2(t)]}{dt} + \underbrace{R\,[i_1(t) - i_2(t)]}_{R\,i_1(t) - R\,i_2(t)} = \underbrace{R\,i_2(t) + R\,i_2(t)}_{2R\,i_2(t)} + \frac{1}{C}\int i_2(t)\,dt$$

$$3\,R\,i_2(t)$$

$$V_s(t) = R\,i_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

→ Modelo de ecuaciones integro-diferenciales "$i_1 - i_2$"

① $$i_1(t) = \left[V_e(t) - L\frac{d\,[i_1(t) - i_2(t)]}{dt} + R\,i_2(t)\right]\frac{1}{2R}$$

② $$i_2(t) = \left[L\frac{d\,[i_1(t) - i_2(t)]}{dt} + R\,i_1(t) - \frac{1}{C}\int i_2(t)\,dt\right]\frac{1}{3R}$$

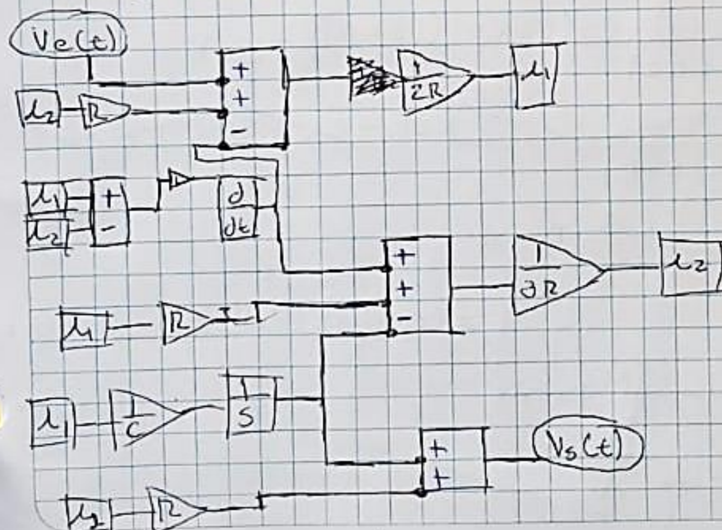
③ $$R\,i_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

$C = 10\,E{-6}$

$R = 22\,E3$

$L = 220\,E{-6}$

→ Diagrama de bloques



Transformada de Laplace

$$Ls I_1(s) - Ls I_2(s) + R I_1(s) - R_2 I_2(s)$$

$$V_e(s) = R I_1(s) + Ls[I_1(s) - I_2(s)] + R[I_1(s) - I_2(s)]$$

$$Ls[I_1(s) - I_2(s)] + R[I_1(s) - I_2(s)] = R I_2(s) + R I_2(s) + \frac{I_2(s)}{Cs}$$

$$V_s(s) = R I_2(s) + \frac{I_2(s)}{Cs} = \frac{CRs+1}{Cs} I_2$$

Recordando ¡No debe de haber terminos negativos!

$$\frac{V_s(s)}{V_e(s)} = \frac{?\ I_2(s)}{?\ I_2(s)}$$

→ Procedimiento algebraico

$$V_e(s) = (R + Ls + R) I_1(s) - (Ls + R) I_2(s) = (Ls + 2R) I_1(s) - (Ls + R) I_2(s)$$

$$Ls I_1(s) - Ls I_2(s) + R I_1(s) - R I_2(s) = 2R I_2(s) + \frac{I_2(s)}{Cs}$$

$$Ls I_1(s) + R I_1(s) = 3R I_2(s) + L I_2(s) + \frac{I_2(s)}{Cs}$$

$$(Ls + R) I_1(s) = \left(3R + Ls + \frac{1}{Cs}\right) I_2(s)$$

$$I_1(s) = \frac{3CRs + CLs^2 + 1}{Cs(Ls+R)} I_2(s) = \frac{CLs^2 + 3CRs + 1}{Cs(Ls+R)} I_2(s)$$

$$V_e(s) = \frac{(Ls+2R)(CLs^2 + 3CRs + 1)}{Cs(Ls+R)} I_2(s) - (Ls+R) I_2(s)$$

$$= \left[\frac{(Ls+2R)(CLs^2 + 3CRs + 1) - Cs(Ls+R)(Ls+R)}{Cs(Ls+R)}\right] I_2(s)$$

$$= \left[\frac{\cancel{CL^2s^3} + 3CLRs^2 + Ls + \cancel{2CLRs^2} + \overset{5CR^2s}{\cancel{6CR^2s}} + 2R - \cancel{CL^2s^3} - \cancel{2CLRs^2} - \cancel{CR^2s}}{Cs(Ls+R)}\right] I_2(s)$$

$$\therefore V_e(s) = \frac{3CLRs^2 + (5CR^2 + L)s + 2R}{Cs(Ls+R)} I_2(s)$$

$$V_s(s) = \left(\frac{\frac{CRs+1}{\cancel{Cs}} \cancel{I_2(s)}}{\frac{3CLRs^2 + (5CR^2+L)s + 2R}{\cancel{Cs}(Ls+R)} \cancel{I_2(s)}}\right) = (CRs+1)(Ls+R) = CLRs^2 + CR^2s + Ls + R$$

$$\boxed{\therefore \frac{V_s(s)}{V_e(s)} = \frac{CLRs^2 + (CR^2+L)s + R}{3CLRs^2 + (5CR^2+L)s + 2R}}$$

Estabilidad en Lazo Abierto

- Calcular los polos de la función de transferencia

$$\frac{V_s(s)}{V_e(s)} = \frac{CLRs^2 + (CR^2 + L)s + R}{3CLRs^2 + (5CR^2 + L) + 2R}$$

den = [3 x C x L x R, 5 x C x R** 2 + L, 2 * R]

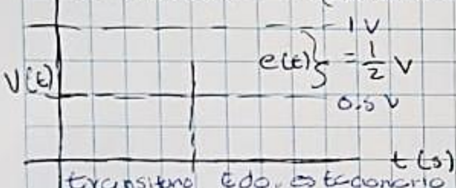
L = np.roots (den)

→ print(" Las raices son {L[0]} y {L[1]}

Python

$\therefore \lambda_1 = -166666666.3636363 \quad \lambda_2 = -1.8181818214876033$

→ El sistema representa una respuesta estable y subamortiguada



$V_e(t) = 1\,V$

$V_e(s) = \frac{1}{s}$

Error en el estado estacionario

$$e(s) = \lim_{s \to 0} s\,V_e(s)\left[1 - \frac{V_s(s)}{V_e(s)}\right] = \lim_{s \to 0} s * \frac{1}{s}\left[1 - \frac{CLRs^2 + (CR^2+L)s + R}{3CLRs^2 + (5CR^2 + L)s + 2R}\right]$$

$$= \frac{R}{2R} \qquad e(t) = \frac{1}{2}\,V$$