Ecuaciones principales

$$V_e(t) = R\,i_2(t) + L\,d\left[i_1(t) - i_2(t)\right] + R\left[i_1(t) - i_2(t)\right]$$

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

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

Modelo de ecuaciones integro-diferenciales

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

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

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

Transformada de Laplace

$$V_e(s) = RI_1(s) + LS[I_1(s) - I_2(s)] + R[I_1(s) - I_2(s)]$$

$$Ls[I_1(s) - I_2(s)] + R[I_1(s) - I_2(s)] = RI_2(s) + RI_2(s) + \frac{I_2(s)}{CS}$$

$$V_s(s) = RI_2(s) + \frac{I_2(s)}{CS}$$

NOTA: NO debe haber terminos negativos!!!

Prosedimiento algebraico.

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

$$LSI_1(s) + RI_1(s) - RI_2(s) = 2RI_2(s) + \frac{I_2(s)}{CS}$$
$$LSI_1(s) + RI_1(s) = 3RI_2(s) + LSI_2(s) + \frac{I_2(s)}{CS}$$

$$(LS + R)I_1(s) = (3R + LS + \frac{1}{CS})I_2(s)$$

$$I_1(s) = \frac{3CRS + CLS^2 + 1}{CS(LS+R)} * I_2(s) = \frac{CLS^2 + 3CRS + 1}{CS(LS+R)} I_2(s)$$

$$V_e(s) = \frac{(LS + 2R)(CLS^2 + 3CRS + 1}{CS(LS+R)} I_2(s) - (LS + R)I_2(s)$$

$$L^2S^2 + 2RLS + R^2$$

$$= \left[\frac{(LS + 2R)(CLS^2 + 3CRS + 1) - CS(LS+R)(LS+R)}{CS(LS+R)}\right] I_2(s)$$

$$= \cancel{CL^2S^3} + 3CLRS^2 + LS + \cancel{2CLRS^2} + 6CR^2S + 2R$$
$$- \cancel{CL^2S^3} - \cancel{2CLRS^2} - CR^2S \qquad 5CR^2S$$

$$V_e(s) = \frac{3CLRS^2 + (5CR^2 + L)S + 2R}{CS(LS+R)}$$

$$V_s(s) = \frac{\dfrac{CRS+1}{\cancel{CS}}\, I_2(\cancel{s})}{\dfrac{3CLRS^2 + (5CR^2+L)S + 2R}{\cancel{CS}(LS+R)} * \cancel{I_2}(s)}$$

$$((CRS+1)(LS+R) = CLRS^2 + CR^2S + LS + R$$

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

L = 47 mH
C = 330 nF
R = 3K

(3E3)*

num = [(330E-6)*(47E-3)*(330E-6)*(3E3)^2 + 47E-3, 3E3]

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Estabilidad en lazo abierto

- Calcular los polos de la Función de transferencia.

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

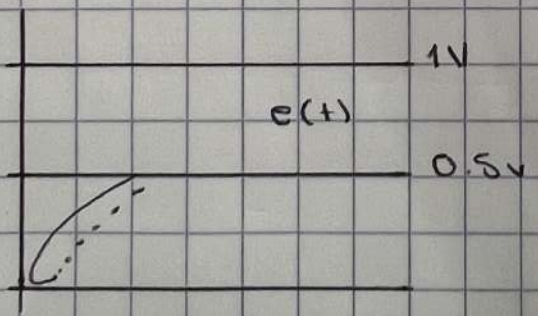
den = [3*C*L*R, 5*C*R**2+L, 2*R]

L = np.roots(den)

→ Fprint: Las raices son {L[0]} y {L[1]}

$$\boxed{\begin{aligned} \lambda_1 &= -106382.911 \\ \lambda_2 &= -0.404 \end{aligned}}$$

El sistema presenta una respuesta estable y sobreamortiguada.



$V_e(t) = 1V$

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

Error en estado estacionario

$$e(s) = \lim s V_e(s) \left[1 - \frac{V_s(s)}{V_e(s)}\right]$$

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

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