Estabilidad en lazo abierto

- Calcular los polos de la función de transferencia

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

den = [3×C×L×R, 5×C×R**2+L, 2×R]

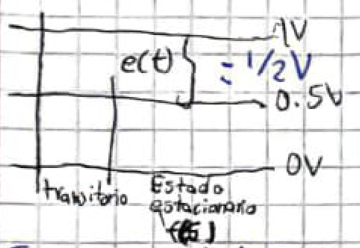
L = np.roots (den)

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

El sistema presenta una respuesta estable y sobreamortiguada

$z_1 = -3666662.36$

$z_2 = -25.790$



Error en estado estacionario

$$e(s) = \lim_{s\to 0} s\,Ve(s)\left[1-\frac{Vs(s)}{Ve(s)}\right]$$

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

$= R/2R$

$e(t) = 1/2\,V$

$Ve(t) = 1V$

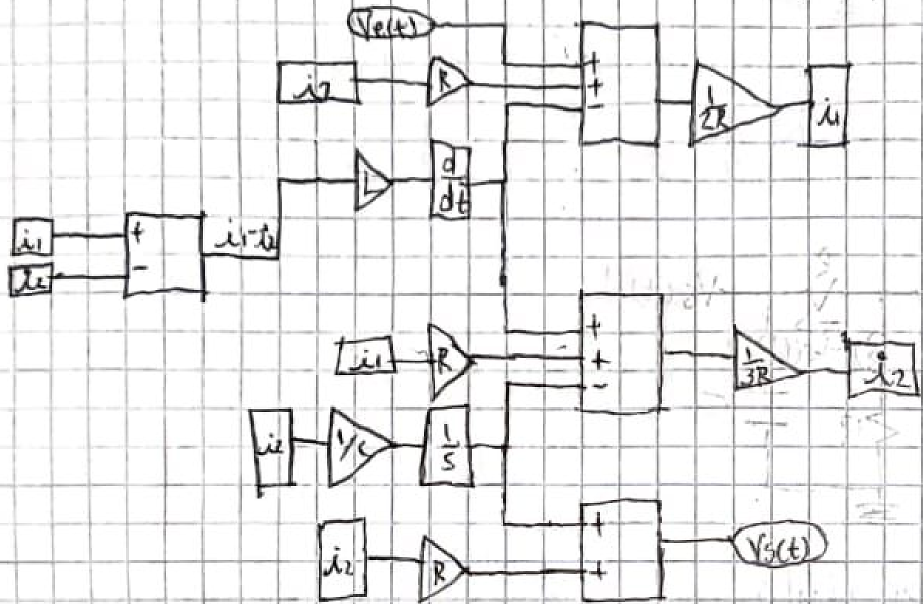
$Ve(s) = 1/s$

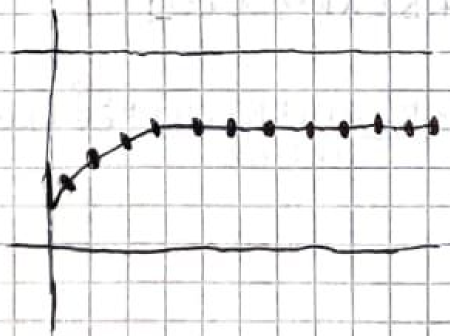
Modelo de ecuaciones integro-diferenciales

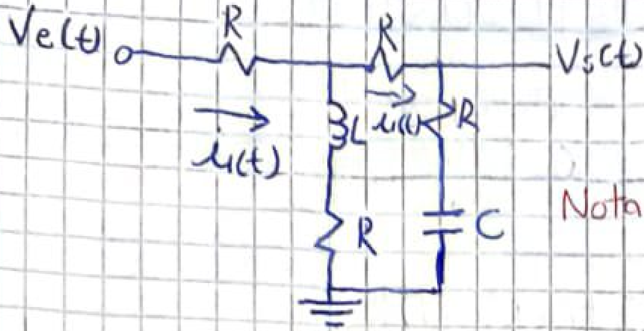
$$i_1(t) = \left[V_e(t) - L\frac{d[i_1(t) - i_2(t)]}{dt} + R\,i_2(t)\right]\frac{1}{2R}$$

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

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







$\frac{V_s(S)}{V_e(S)} = \frac{P\, I_2(S)}{?\, I_2(S)}$

Nota: ¡No debe haber terminos negativos!

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

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

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

Transformada de Laplace

$LS I_1(S) - LS I_2(S) + R I_1(S) - R I_2(S)$

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

$LS[I_1(S) - I_2(S)] + R[I_1(S) - I_2(S)] = R I_2(S) + R I_2(S) + \frac{I_2(S)}{CS}$

$V_s(S) = R I_2(S) + \frac{I_2(S)}{CS}$

Procedimiento algebraico

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

$LS I_1(S) - LS I_2(S) + R I_1(S) - R I_2(S) = 2R I_2(S) + \frac{I_2(S)}{CS}$

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

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

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

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

$$L^2S^2+2LRS+R^2$$

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

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

$$-\cancel{CL^2S^3}-\cancel{2CLRS^2}-CR^2S \qquad 5CR^2S$$

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

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

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

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

$R = 3.3\,k\Omega$
$C = 4.7\,\mu F$
$L = 3.3\,mH$

num = [(4.7E-6)*(3.3E-3)*(3.3E3), (4.7E-6)*(3.3E3)^2+3.3E-3, 3.3E3

L=1.5E-3
R=330 = 3.3E3
C=47E-3 = 4.7E-6