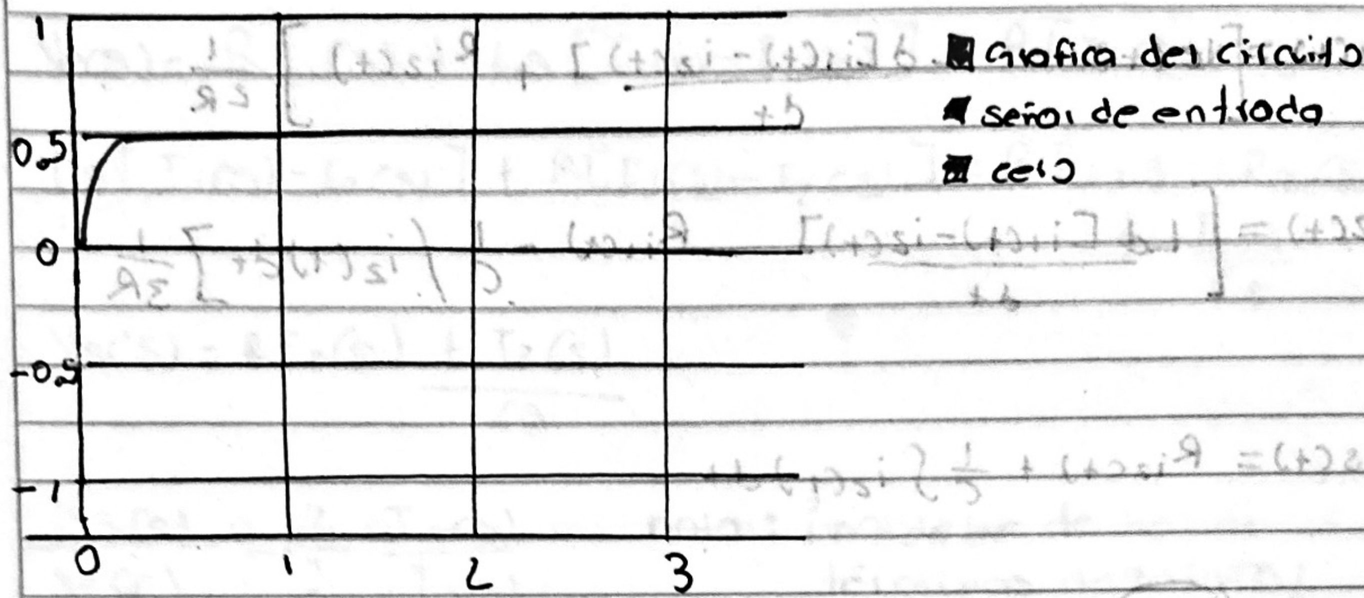
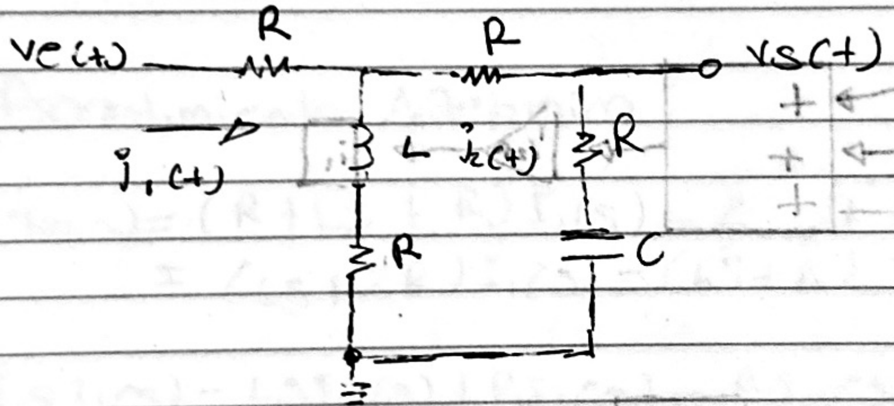
23-09





Ecuaciones Principales

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

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

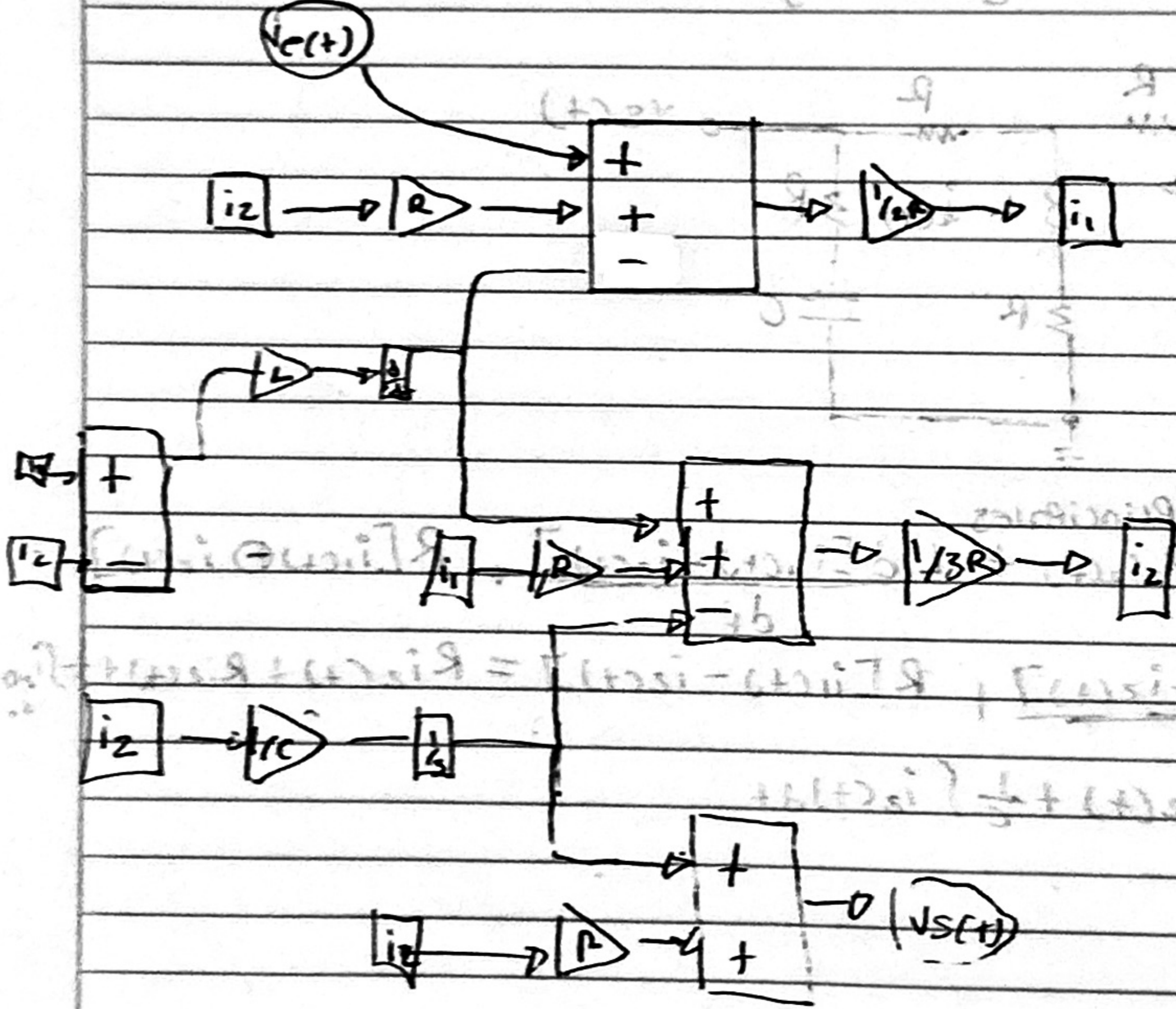
$$V_s(t) = R\,i_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

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

$Ve(s) = RI_1(s) + Ls[I_1(s) - I_2(s)] + R[I_1(s) - I_2(s)]$

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

$Vs(s) = RI_2(s) + \frac{I_2(s)}{Cs}$

$\frac{Vs(s)}{Ve(s)} = \frac{?}{?} \frac{I_2(s)}{I_2(s)}$ nota: ¡no debe de haber términos negativos!

Procedimiento Algebraico

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

$LsI_1(s) - LsI_2(s) + RI_1(s) - RI_2(s) = 2RI_2(s) + \frac{I_2(s)}{Cs}$

$LsI_1(s) + RI_1(s) = 3RI_2(s) + LsI_2(s) + I_2(s)$
$(Ls + R)I_1(s) = (3R + Ls + 1/Cs)I_2(s)$
$I_1(s) = \frac{3(Rs + (Ls^2 + 1)}{Cs + (Ls + R)} I_2(s)$

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

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

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

$$\cancel{CL^2s^3} + 3CLRs^2 + Ls + \cancel{2CLRs^2} + 6CR^2s + 2R$$
$$- \cancel{CL^2s^3} - \cancel{2CLRs^2} - CR^2s \qquad 5CR^2s$$

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

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

$$\overline{\frac{3CLRs^2 + (5CR^2+L)s + 2R}{Cs(Ls+R)}}$$

$$(CRs+1)(Ls+R) = CLRs^2 + CR^2s + Ls + R$$

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

$$= \frac{[(.67\,\mu F)(4.7\times10^3\,\Omega)(680\times10^{-6}), (4.7\times10^{-6})(4.7\times10^3)^2 + (680\times10^{-3}) + 4.7\times10^3}{3(1.7\times10^{-6})(680\times10^{-6})(4.7\times10^3), + (5(4.7\times10^{-6})(4.7\times10^3)^2 + 680\times10^{-6}) + 2(4.7\times10^3)}$$

Estabilidad en lazo abierto

o calcular los polos de la funcion de transferencia

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

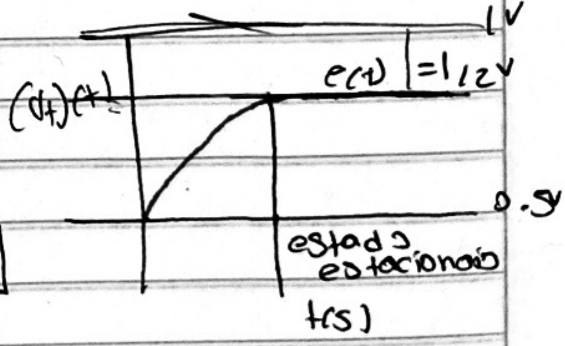
den = [3*C*L*R, 5*C*R**2 + L, 2*R]

L = np.roots(den)

f Print: Las raices son {L[0]} y {L[1]}

$\lambda_1 = -11519607.541341523$
$\lambda_2 = -1.810774158369$

- El sistema presenta una respuesta estable y sobreamortiguada.



Error en estado estacionario

$$e(s) = \lim_{s \to 0} s V_e(s)\left[1 - \frac{V_s(s)}{V_e(s)}\right]$$

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

$$= \frac{R}{2R}$$

$V_e(t) = 1V$

$e(t) = \frac{1}{2}V$ $\qquad V_e(s) = \frac{1}{s}$