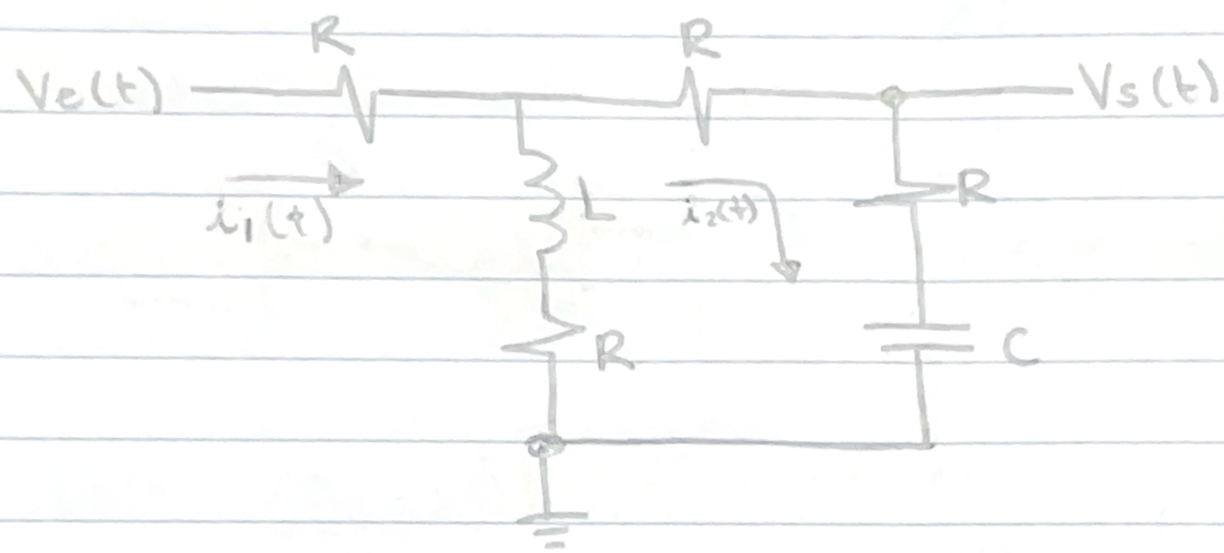
23/Sept/2025

$L = 2.2 \times 10^{-3}$ H

$R = 1 \times 10^{3}$ Ω

$C = 100 \times 10^{-6}$



Ecuaciones principales

$$V_e(t) = \overbrace{Ri_1(t)}^{2Ri_1(t)} + L\frac{d[i_1(t) - i_2(t)]}{dt} + \overbrace{R[i_1(t) - i_2(t)]}^{Ri_1(t) - Ri_2(t)}$$

$$L\frac{d[i_1(t) - i_2(t)]}{dt} + \underbrace{R[i_1(t) - i_2(t)]}_{Ri_1(t) - Ri_2(t)} = Ri_2(t) + \underbrace{Ri_2(t)}_{3Ri_2(t)} + \frac{1}{C}\int i_2(t)\,dt$$

$$V_s(t) = Ri_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

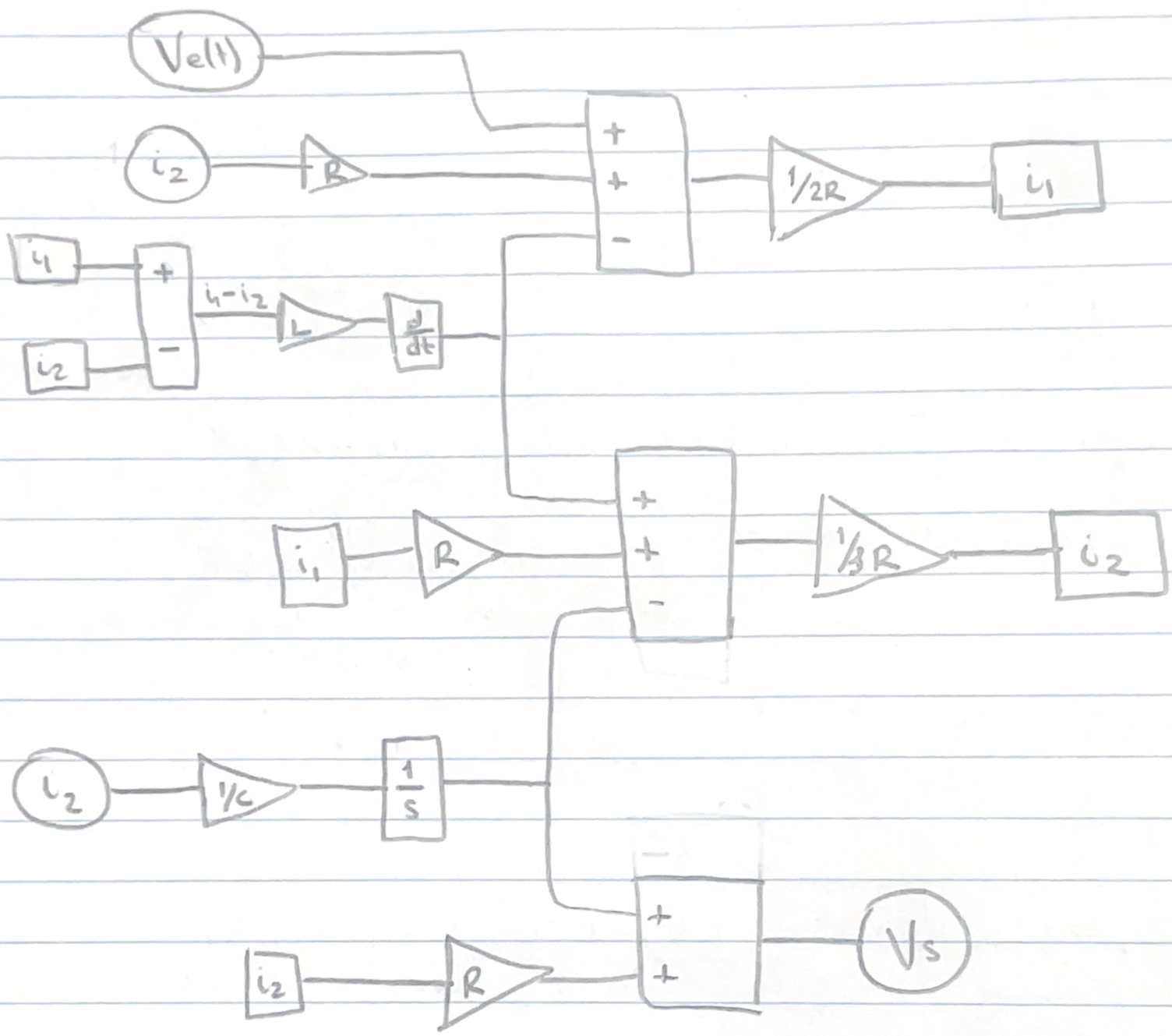
Despejamos i_1 & i_2

$$i_1(t) = \left[V_e(t) - \frac{L\,d[i_1(t) - i_2(t)]}{dt} + Ri_2(t)\right]\frac{1}{2R}$$

$$i_2(t) = \left[L\frac{d[i_1(t) - i_2(t)]}{dt} + Ri_1(t) - \frac{1}{C}\int i_2(t)\,dt\right]\frac{1}{3R}$$

Modelo de ecuaciones integro diferenciales

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



Utilizaremos las ecuaciones principales para sacar la función de transferencia.

→ Transformada de Laplace

$$V_e(s) = R i_1(s) + Ls[i_1(s) - i_2(s)] + R[i_1(s) - i_2(s)]$$

$$= 2R i_1(s) + Ls i_1(s) - Ls i_2(s) - R i_2(s)$$

$$= (2R + Ls)\, i_1(s) - (Ls + R)\, i_2(s)$$

$$Ls[i_1(s) - i_2(s)] + R[i_1(s) - i_2(s)] = 2R i_2(s) + \frac{i_2(s)}{Cs}$$

$$Ls i_1(s) - Ls i_2(s) + R i_1(s) - R i_2(s) = 2R i_2(s) + \frac{i_2(s)}{Cs}$$

$$Ls i_1(s) + R i_1(s) = Ls i_2(s) + 3R i_2(s) + \frac{i_2(s)}{Cs}$$

$$(LS+R)\,i_1(s) = \left(LS + 3R + \frac{1}{CS}\right) i_2(s)$$

$$i_1(s) = \frac{CLS^2 + 3CRS + 1}{CS\,(LS+R)}\, i_2(s)$$

$$V_s(s) = \left(R + \frac{1}{CS}\right) i_2(s)$$

$$= \frac{CRS+1}{CS}\, i_2(s)$$

Procedimiento algebraico (se harán sustituciones)

$$V_e(s) = (2R + LS)\left(\frac{CLS^2 + 3CRS + 1}{CS\,(LS+R)}\right) i_2(s) - (LS+R)\, i_2(s)$$

$$V_e(s) = \left[\frac{(2R+LS)(CLS^2 + 3CRS + 1)}{CS\,(LS+R)} - (LS+R)\right] i_2(s)$$

$$= \left[\frac{(2R+LS)(CLS^2 + 3CRS + 1) - CS(LS+R)(LS+R)}{CS\,(LS+R)}\right] i_2(s)$$

$$= \frac{\cancel{2CLRS^2} + \overset{5CR^2S}{\cancel{6CR^2S}} + 2R + \cancel{CL^2S^3} + \cancel{3CLRS^2} + LS \ldots}{\cancel{-CL^2S^3} - \cancel{CLRS^2} - \cancel{CLRS^2} - \cancel{CR^2S}}\; I_2(s)$$

$$CS(LS+R)$$

$$V_e(s) = \frac{3CLRS^2 + (5CR^2 + L)S + 2R}{CS(LS+R)}\, I_2(s)$$

$$\frac{\text{Salida}}{\text{entrada}} \quad \frac{V_s(s)}{V_e(s)} = \frac{\frac{CRS+1}{\cancel{CS}}\cancel{I_2(s)}}{\frac{3CLRS^2+(5CR^2+L)s+2R}{\cancel{CS}(LS+R)}\cancel{I_2(s)}}$$

$$= \frac{(CRS+1)(LS+R)}{3CLRS^2+(5CR^2+L)s+2R} \longrightarrow CLRS^2+CR^2s+LS+R$$

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

$$\left(5*\left((100\times10^{-6})*((1\times10^{3})^{1^2})\right)+L\right)$$

01/Octubre/2025

Error en estado estacionario [escalón unitario]

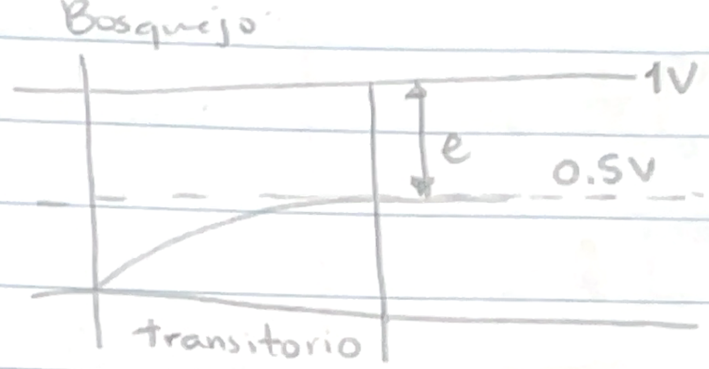
$$e(s) = \lim_{s \to 0} s V_e(s) \left[1 - \frac{V_s(s)}{V_e(s)} \right]$$

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

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

$$= \frac{1}{2} V$$

Bosquejo



Estabilidad en lazo abierto

$\boxed{\text{Calcular las raíces del denominador (Polos)}}$

$$3CLRs^2 + (5CR^2 + L)s + 2R = 0$$

C = ?
R = ?
L = ?
} Esto ya lo tenemos

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

Equipo Iván
$\lambda_1 = -4.464285 \times 10^{7}$
$\lambda_2 = -7.843137 \times 10^{-2}$

Equipo Yos
$\lambda_1 = -7.57575091 \times 10^{8}$
$\lambda_1 = -4.00000352$

Con base en las raíces se concluye que el sistema es estable con una respuesta sobreamortiguada.