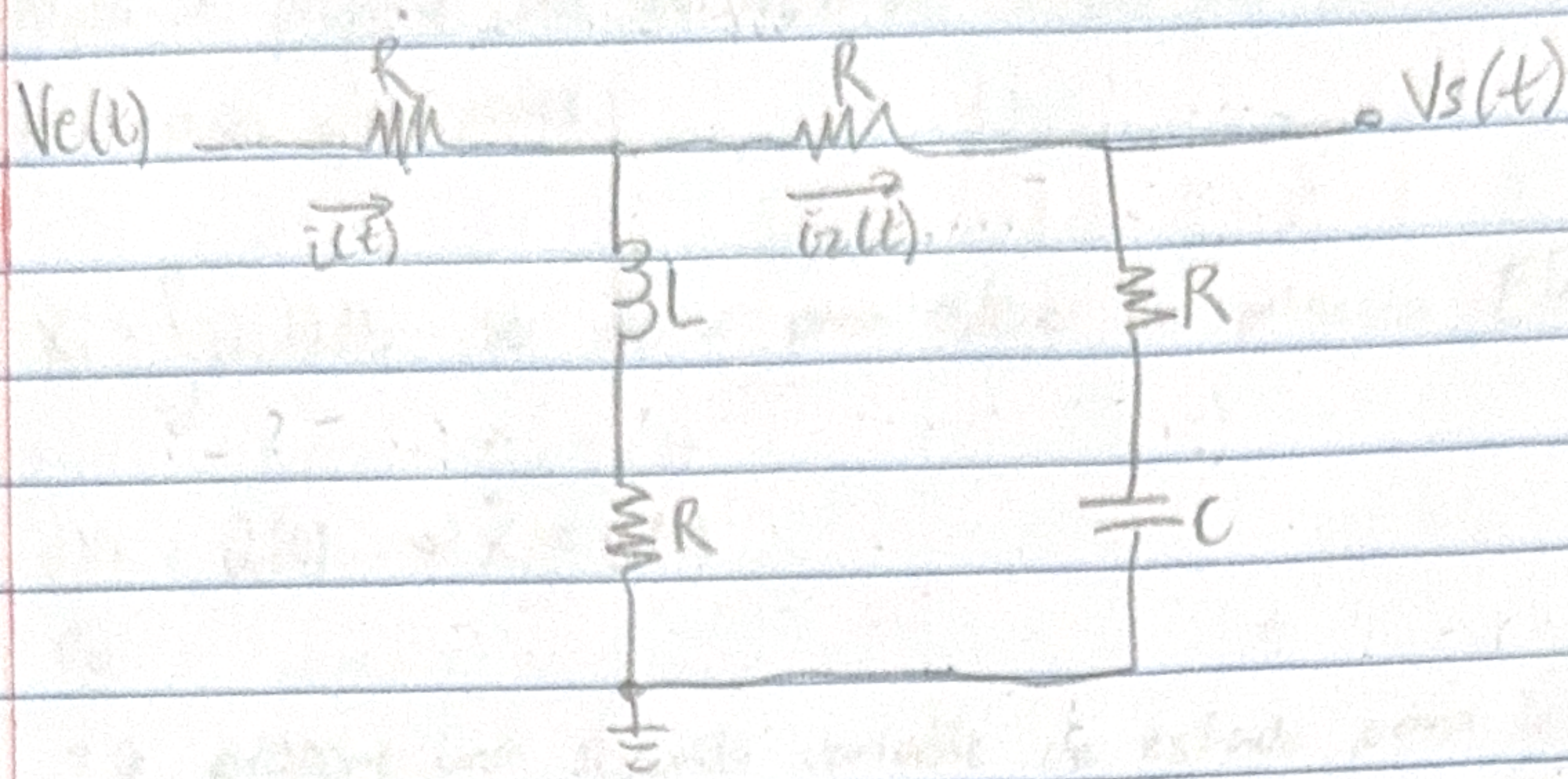
Práctica 1



$2Ri_1(t)$

$Ri_1(t) - Ri_2(t)$

- Ecuaciones principales

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

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

$Ri_1(t) - Ri_2(t)$ $\quad$ $3Ri_2(t)$

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

- Modelo de ecuaciones integro-diferenciales

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

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

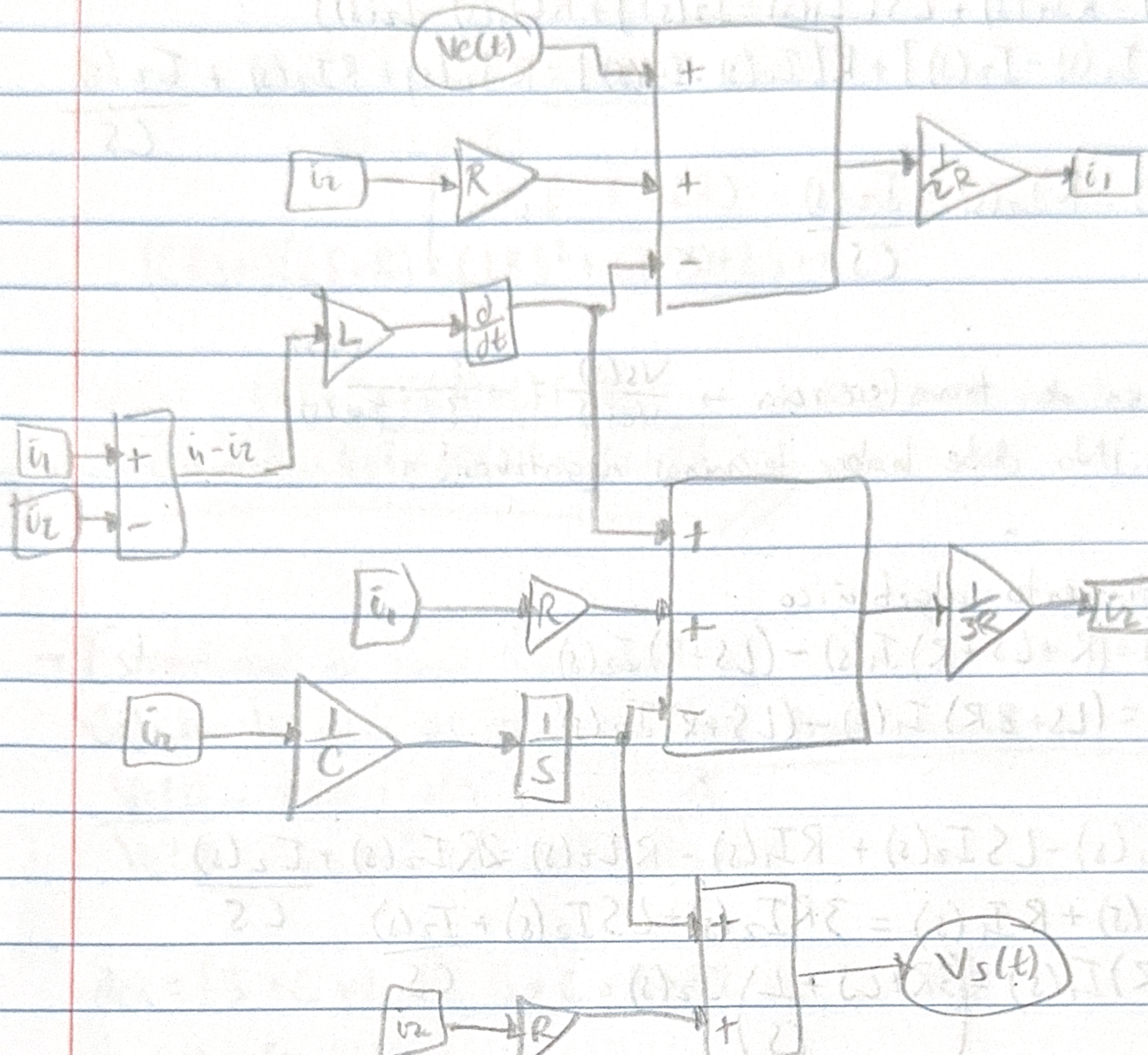
$$V_s(t) = Ri_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

$R = 3.3\,K\Omega$

$C = 4.7\times10^{-6}F$

$L = 3.3\times10^{-3}H$

En simulink con Goto y From para i_1 e i_2



Función de transferencia

Transformada de Laplace

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

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

$Vs(s) = RI_2(s) + \frac{I_2(s)}{CS} = \frac{CRS+1}{CS} I_2(s)$

Función de transferencia $\rightarrow \frac{Vs(s)}{Ve(s)} = \frac{?}{?} \frac{I_2(s)}{I_e(s)}$

Nota: ¡No debe haber términos negativos! sería inestable y no se quiere eso

Procedimiento algebráico

$Ve(s) = (R+LS+R)I_1(s) - (LS+R)I_2(s)$

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

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

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

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

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

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

- Sustituir $I_1(s)$ en ec. 2.

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

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

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

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

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

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

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

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

- Estabilidad en lazo abierto

• Calcular los polos de la función de transferencia

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

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den = [3*C*L*R, 5*C*R**2+L, 2*R]
L = np.roots(den)
Fprint: Las raíces son {L[0]} y {L[1]}
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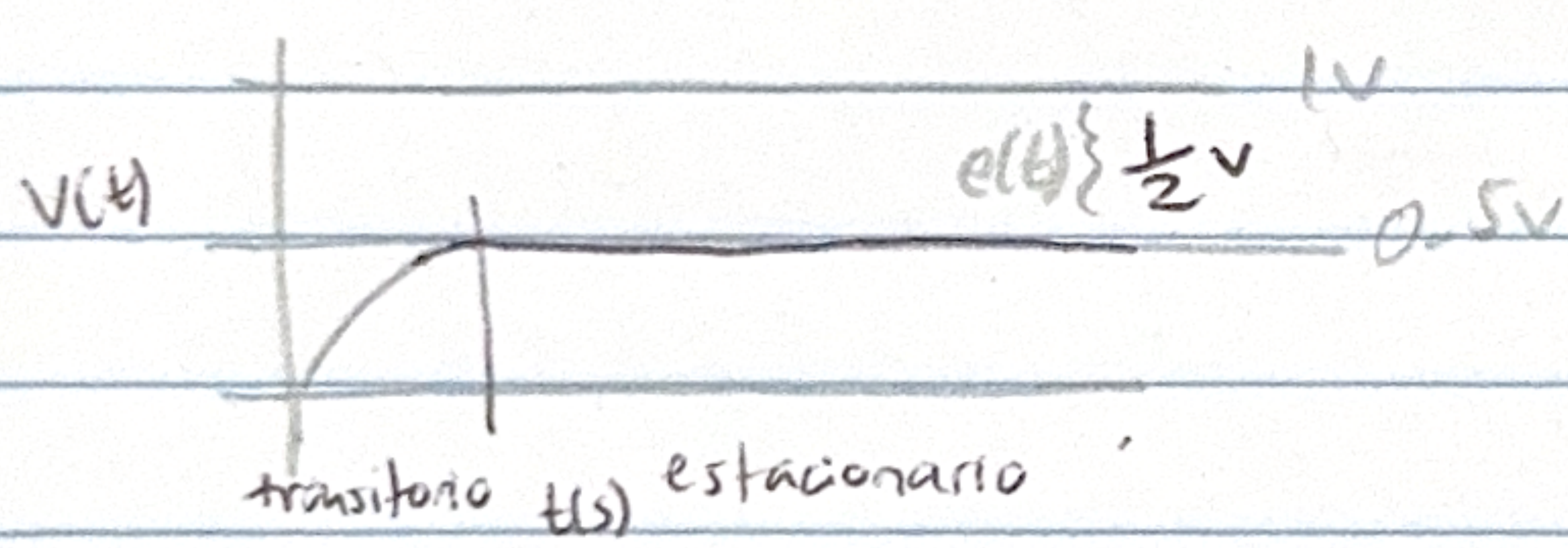
El sistema presenta una respuesta estable y sobreamortiguada.



$v_e(t) = 1V$

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

Error en estado estacionario

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

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

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