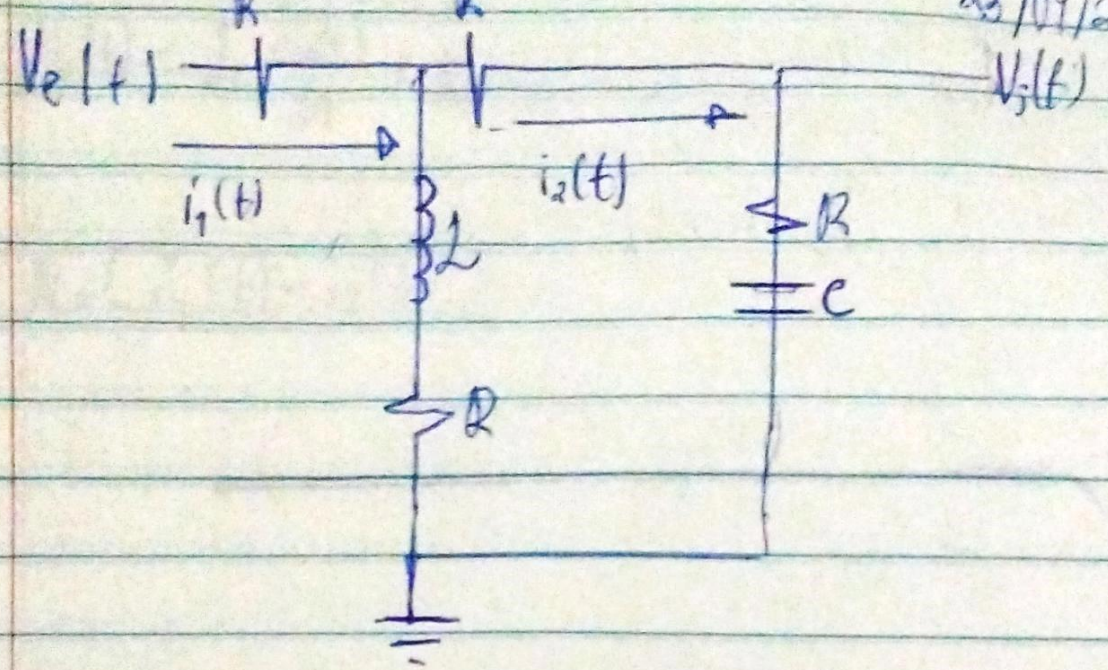
23/09/25



Ecuaciones principales

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

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

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

Modelo de ecuaciones integro-diferenciales

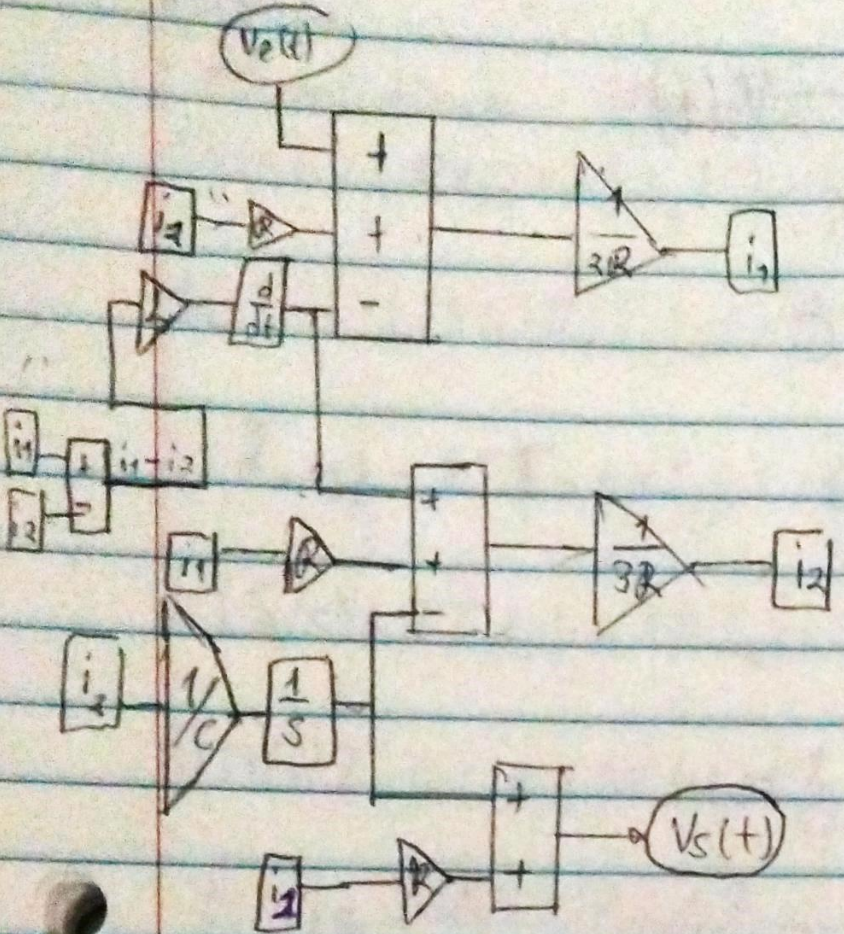
$$i_1(t) = V_e(t) - L \frac{d[i_1(t) - i_2(t)]}{dt} + R i_2(t)\Big]\frac{1}{2R}$$

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

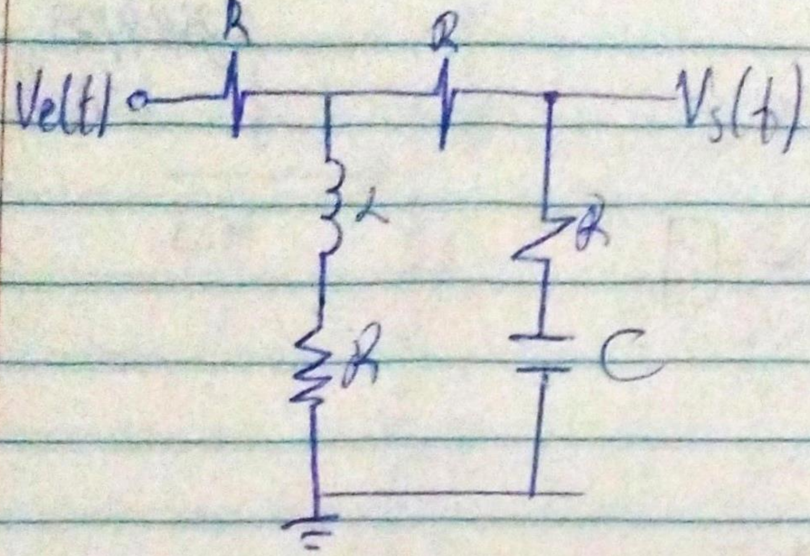
$$V_s(t) = R i_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

goto
From

23/09/25



26/04/25



Transformada de Laplace $LS(I_1(S)) - LS\,I_2(s) + R I_1(s) - R I_2(S)$

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

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

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

Nota: No debe de haber terminos negativo.

Procedimiento algebraico

$$V_e(s) = (R + LS + R)\,I_1(S) - (LS + R)\,I_2(R)$$

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

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

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

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

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

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

Se desarrollaron estos terminos

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

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

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

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

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

Función de transferencia

$\frac{V_s(s)}{V_e(s)}$

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

$$V_e(s) = \frac{3CLRs^2 + (5CR^2+L)s + 2R}{\cancel{Cs}(Ls+R)} \cancel{I_2(s)}$$

$$(CRs+1)(Ls+R) = CLRs^2 + \underbrace{CR^2s + Ls}_{(CR^2+L)s} + R$$

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

Estabilidad en lazo abierto

- Calcular los polos de la función de transferencia

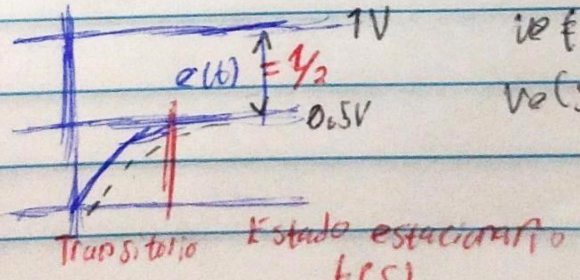
$$\frac{V_s(t)}{V_e(t)} = \frac{CRL^2 + [CR^2+1]S + R}{3CLRS^2 + (5CR^2+L)S + 2R}$$

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

L = np.roots(den)

print     Las raices {L[0]} y {L[1]}
```

$\lambda_1 = -24{,}509{,}803.2549$

$\lambda_2 = -4.0\bar{5}$

El sistema presenta una respuesta estable y sobreamortiguada



$v_e(t) = 1V$

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

Error en estado estacionario

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

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

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

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