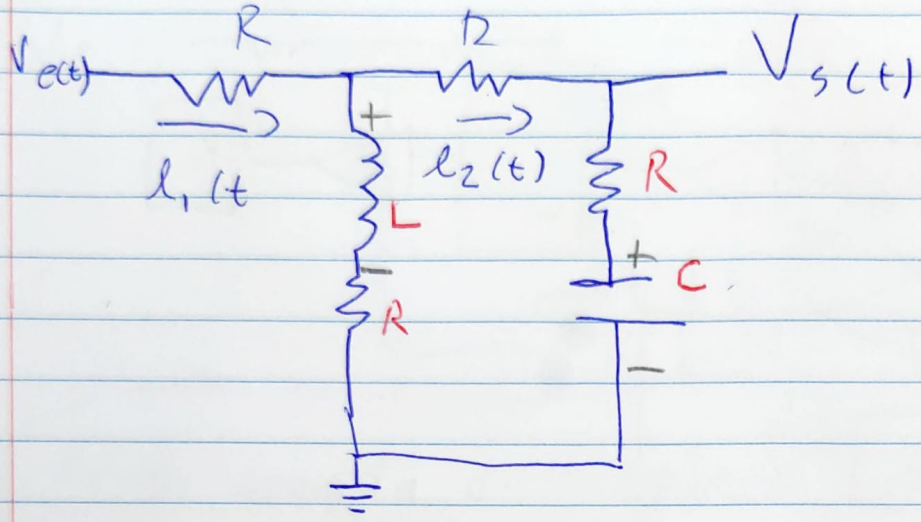
Diseño de controladores

23-09-25



Ecuaciones principales

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

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

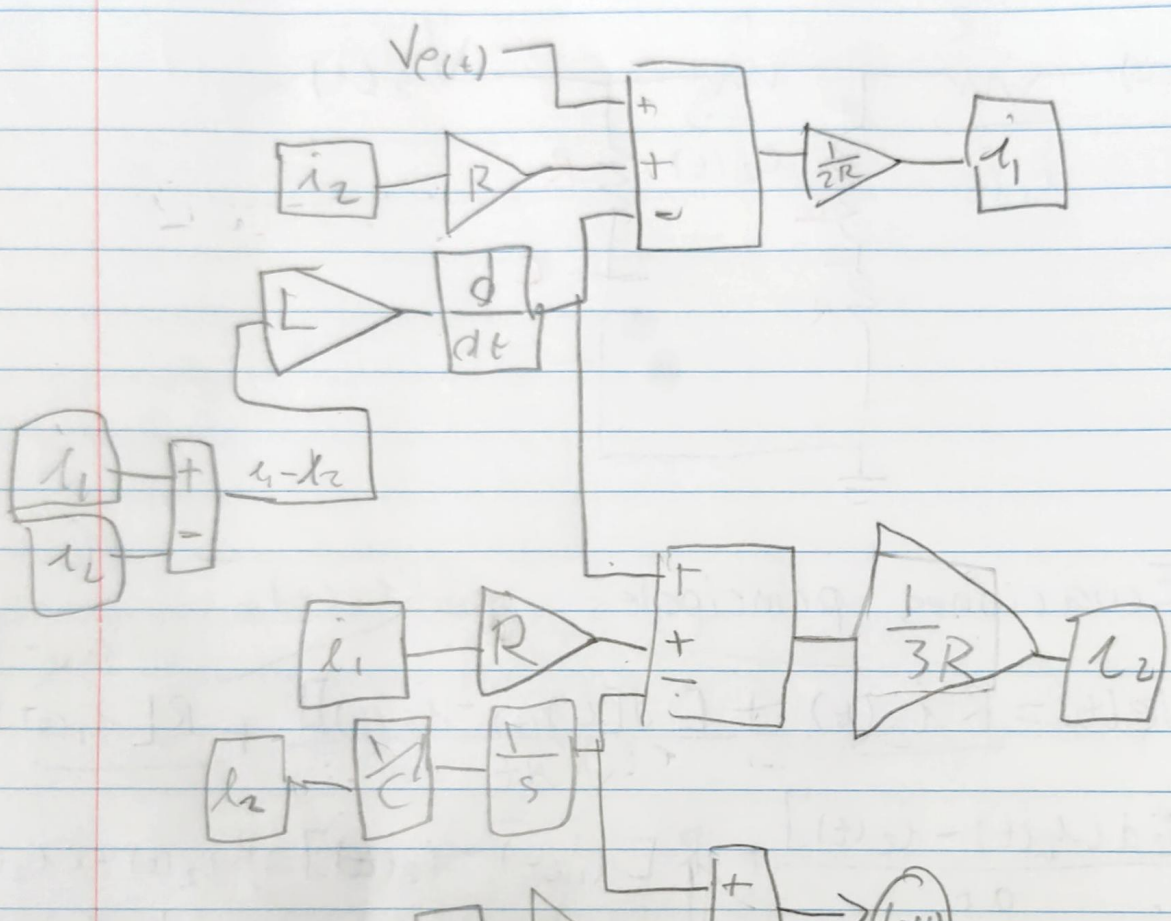
$$V_s(t) = R\,i_2(t) + \frac{1}{C}\int i_2(t)\,dt$$

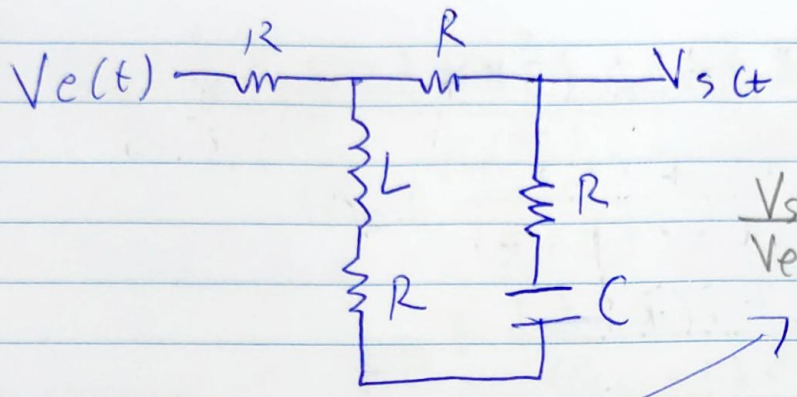
Modulo de ecuaciones integro-diferenciales

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

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

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


$V_{e(t)}$
i_2
R
+
+
−
$\frac{1}{2R}$
i_1
L
d
dt
i_1
i_2
+
−
$i_1 - i_2$
i_1
R
+
+
−
$\frac{1}{3R}$
i_2
i_2
$\frac{1}{C}$
$\frac{1}{s}$
i_2
R
+
+
$V_{s(t)}$



$$\frac{V_s(s)}{V_e(s)} = \frac{?\ I_2(s)}{?\ I_2(s)}$$

Transformada de Laplace

$$V_e(s) = R\,I_1(s) + LS\left[I_1(s) - I_2(s)\right] + R\left[I_1(s) - I_2(s)\right]$$

$$LS\left[I_1(s) - I_2(s)\right] + R\left[I_1(s) - I_2(s)\right] = R\,I_2(s) + R\,I_2(s) + \frac{I_2(s)}{Cs}$$

$$V_s(s) = R\,I_2(s) + \frac{I_2(s)}{Cs}$$

¡No de tener terminos negativos!

Procedimiento algebraico

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

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

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

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

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

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

$$V_e(s) = \frac{(LS+2R)(CLS^2+3CR+1)}{CS(LS+R)}$$

$$= \left[\frac{(LS+2R)(CLS^2+3CR+1)}{CS(LS+R)}\right.$$

$$CL^2S^3 + 3CLRS^2 + LS + 2CLR \cdot 2 + 2$$

$$-CL^2S^3 - 2CLRS^2 - CR^2S$$

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

$$V_s(s) = \frac{\frac{CRS+1}{CS}}{3CLRS^2 + (5CR^2+1)S + 2R}$$

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

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

Estabilidad en lazo abierto

Calcular los polos de la función de transferencia

?

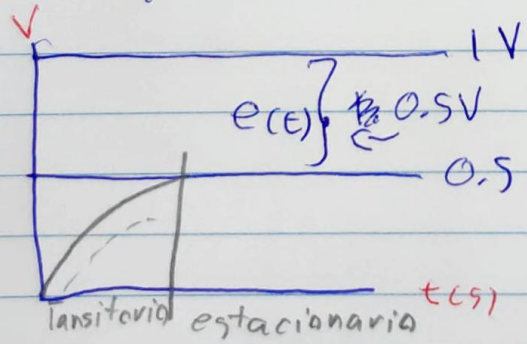
L = np.roots(den)

Fprint = Las raíces son {L[0]} y {L[1]}

$\lambda_1 = -1,191,960.754$

$\lambda_2 = -0.1810$

Respuesta estable y sobreamortiguada



$V_e(t) = 7V$

$V_e(s) = \frac{1}{5}$

Error en estado estacionario

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

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

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

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