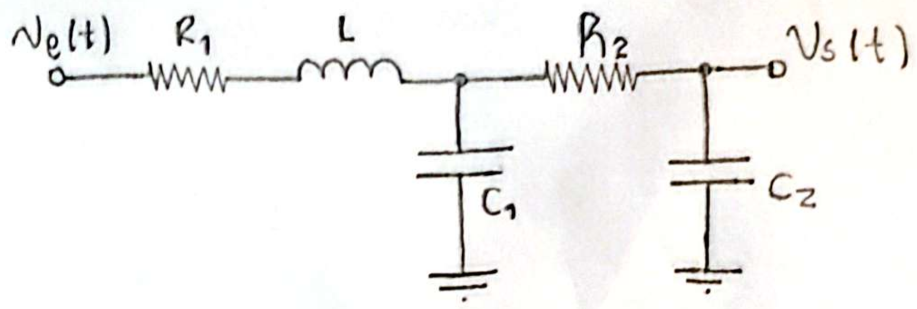
Ecuaciones principales

$$v_e(t) = R_1 i(t) + L\frac{di(t)}{dt} + \frac{1}{C_1}\int i(t) - i_1(t)\,dt$$

$$v_s(t) = \frac{1}{C_2}\int i_1(t)\,dt$$

$$\frac{1}{C_1}\int i(t) - i_1(t)\,dt = R_2 i_1(t) + \frac{1}{C_2}\int i_1(t)$$



C	Control	Caso
R_1	100 Ω	250 Ω
L	50 mH	50 mH
C_1	100 µF	180 µF
C_2	200 µF	350 µF
R_2	150 Ω	300 Ω

Función de transferencia

$$V_e(s) = R_1 I(s) + LSI(s) + \frac{I(s) - I_1(s)}{C_1 S}$$

$$V_s(s) = \frac{I_1(s)}{C_2 S}$$

$$\frac{I(s) - I_1(s)}{C_1 S} = R_2 I_1(s) + \frac{I_1(s)}{C_2 S}$$

Procedimiento algebraico

$$V_e(s) = R_1 I(s) + LSI(s) + \frac{I(s) - I_1(s)}{C_1 S}$$

- $$V_e(s) = \left[R_1 + LS + \frac{1}{C_1 S}\right] I(s) - \frac{1}{C_1 S} I_1(s)$$

$$\frac{I(s)}{C_1 S} - \frac{I_1(s)}{C_1 S} = R_2 I_1(s) + \frac{I_1(s)}{C_2 S}$$

$$\frac{I(s)}{C_1 S} = R_2 I_1(s) + \frac{I_1(s)}{C_2 S} + \frac{I_1(s)}{C_1 S}$$

$$I(s) = \left[R_2 I_1(s) + \frac{I_1(s)}{C_2 S} + \frac{I_1(s)}{C_1 S}\right] C_1 S$$

$$I(s) = C_1 S R_2 I_1(s) + \frac{C_1}{C_2} I_1(s) + I_1(s)$$

- $$I(s) = \left[C_1 S R_2 + \frac{C_1}{C_2} + 1\right] I_1(s)$$

$$V_e(s) = \left[R_1 + LS + \frac{1}{C_1 S}\right]\left(C_1 S R_2 + \frac{C_1}{C_2} + 1\right) I_1(s) - \frac{1}{C_1 S} I(s)$$

$$V_e(s) = \left[C_1 R_1 R_2 S + \frac{C_1 R_1}{C_2} + R_1 + C_1 L S^2 R_2 + \frac{C_1 L S}{C_2} + LS + R_2 + \frac{1}{C_2 S} + \cancel{\frac{1}{C_1 S}}\right] I_1(s) - \cancel{\frac{1}{C_1 S} I_1(s)}$$

$$V_e(s) = \left[\frac{C_1 C_2 R_1 R_2 S^2 + C_1 R_1 S + C_2 R_1 S + C_1 C_2 L S^3 R_2 + C_1 L S^2 + C_2 L S^2 + C_2 R_2 S + 1}{C_2 S}\right] I_1(s)$$

$$V_e(s) = \left[\frac{C_1 C_2 L R_2 S^3 + (C_1 C_2 R_1 R_2 + C_1 L + C_2 L) S^2 + (C_1 R_1 + C_2 R_1 + C_2 R_2) S + 1}{C_2 S}\right] I_1(s)$$

$$\frac{V_s(s)}{V_e(s)} = \frac{\cancel{\dfrac{I_1(s)}{C_2 S}}}{\left[\dfrac{C_1 C_2 L R_2 S^3 + (C_1 C_2 R_1 R_2 + C_1 L + C_2 L) S^2 + (C_1 R_1 + C_2 R_1 + C_2 R_2) S + 1}{\cancel{C_2 S}}\right] \cancel{I_1(s)}}$$

$$\boxed{\frac{V_s(s)}{V_e(s)} = \frac{1}{(C_1 C_2 L R_2) S^3 + (C_1 C_2 R_1 R_2 + C_1 L + C_2 L) S^2 + (C_1 R_1 + C_2 R_1 + C_2 R_2) S + 1}}$$

Modelo de ecuaciones integro-diferenciales

$$R_1 i(t) = V_e(t) - L\frac{di(t)}{dt} - \frac{1}{C_1}\int i(t) - i_1(t)\,dt$$

$$\rightarrow i(t) = \left[V_e(t) - L\frac{di(t)}{dt} - \frac{1}{C_1}\int i(t) - i_1(t)\,dt\right]\frac{1}{R_1}$$

$$R_2 i_1(t) = \frac{1}{C_1}\int i(t) - i_1(t)\,dt - \frac{1}{C_2}\int i_1(t)\,dt$$

$$\rightarrow i_1(t) = \left[\frac{1}{C_1}\int i(t) - i_1(t)\,dt - \frac{1}{C_2}\int i_1(t)\,dt\right]\frac{1}{R_2}$$

$$\rightarrow V_s(t) = \frac{1}{C_2}\int i_1(t)\,dt$$

Ecuaciones principales

$$V_e(t) = R_1 i(t) + L\frac{di(t)}{dt} + \frac{1}{C_1}\int i(t) - i_1(t)\,dt$$

$$\frac{1}{C_1}\int i(t) - i_1(t)\,dt = R_2 i_1(t) + \frac{1}{C_2}\int i_1(t)\,dt$$

$$V_s(t) = \frac{1}{C_2}\int i_1(t)\,dt$$

$$\boxed{\begin{aligned} i(t) &= \left[V_e(t) - L\frac{di(t)}{dt} - \frac{1}{C_1}\int i(t) - i_1(t)\,dt\right]\frac{1}{R_1} \\ i_1(t) &= \left[\frac{1}{C_1}\int i(t) - i_1(t)\,dt - \frac{1}{C_2}\int i_1(t)\,dt\right]\frac{1}{R_2} \\ V_s(t) &= \frac{1}{C_2}\int i_1(t)\,dt \end{aligned}}$$

Estabilidad en Lazo abierto

$$\frac{V_s(s)}{V_e(s)} = \frac{1}{(C_1C_2LR_2)S^3 + (C_1L + C_2L + C_1C_2R_1R_2)S^2 + (C_1R_1 + C_2R_2 + C_2R_1)S + 1}$$

raíces

$\lambda_1 = -18.4352$

$\lambda_2 = -191.3106$

$\lambda_3 = -1890.2540$

Son reales negativas con diferente valor, por lo tanto, el sistema es estable

Error en estado estacionario

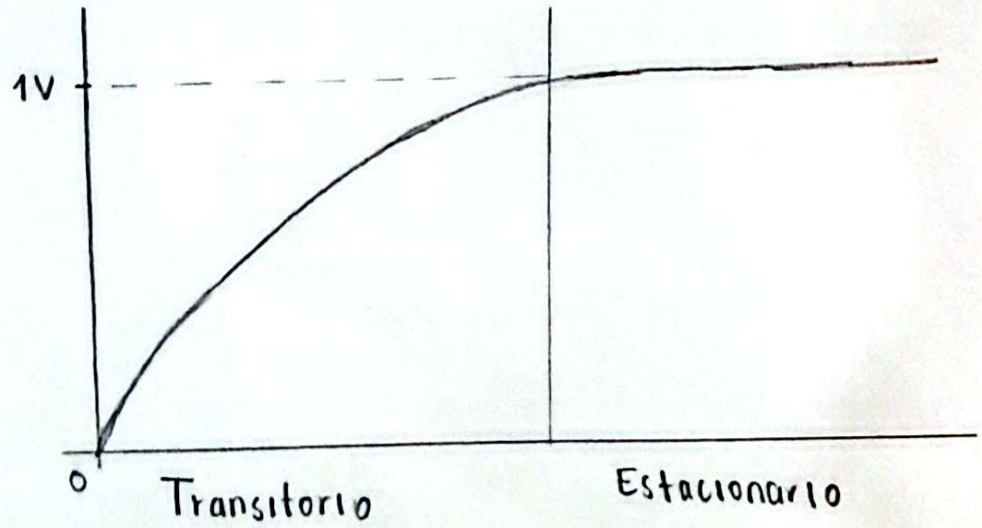
$$e(s) = \lim_{s\to 0} sV_e(s)\left[1 - \frac{V_s(s)}{V_e(s)}\right]$$

$$e(s) = \lim_{s\to 0} s\cdot\frac{1}{s}\left[1 - \frac{1}{(C_1C_2LR_2)s^3 + (C_1L + C_2L + C_1C_2R_1R_2)s^2 + (C_1R_1 + C_2R_2 + C_2R_1)s + 1}\right]$$

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

$$e(s) = \lim_{s\to 0} s\cdot\frac{1}{s}[0]$$

$$\boxed{e(s) = 0}$$



Escaneado con CamScanner