① Transformada de Laplace (Dom. tempo a S)

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

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

$\dashrightarrow V_S(s) = RI_2(s) + \frac{I_2(s)}{CS}$

② Procedimento algébrico

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

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

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

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

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

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

$\dashrightarrow \frac{CRS+1}{CS} I_2(s)$, substituir ↑ :

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

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

multiplicar ↗ (juntar termos)

$CL^2S^3 + 3CLRS^2 + LS + 2CLRS^2 + 6CR^2S + 2R$

$* -CL^2S^3 - 2CLRS^2 - CR^2S \rightarrow 5CR^2S$, substituir

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

$V_S(s) = \frac{\frac{CRS+1}{CS} I_2(s)}{\frac{3CLRS^2 + (5CR^2+L)S + 2R}{CS(LS+R)} I_2(s)}$

$\rightarrow [CRS+1][LS+R] = CLRS^2 + CR^2S + LS + R$

$\frac{V_S(s)}{Ve(s)} = \frac{CLRS^2 + (CR^2 + L)S + R}{3CLRS^2 + (5CR^2 + L)S + 2R}$, $C = 100\,\mu F$, $R = 1\,K\Omega$, $L = 68\,M$

Estabilidad en lazo abierto

- Calcular los polos de la función de transferencia

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

```
den = [3*C*L*R, 5*C*R**2 + L, 2*R]
L = np.roots(den)
```

→ fprint: Las raíces son {L[0]} y {L[1]}

$\lambda_1 = -2.5098803$, -2.5490185

$\lambda_2 = -4.0000$

} respuesta estable
2 raíces reales negativas d.f = sobreamortiguado

Error en estado estacionario

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

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