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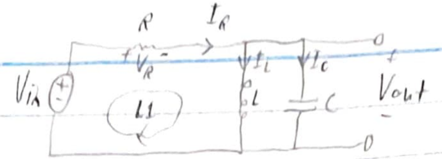
ECE351 Prelab 5



$R = 1k\Omega$

$L = 27mH$

$C = 100nF$

① Find $H(s) = \frac{V_{out}(s)}{V_{in}(s)}$ in terms of R, L, and C.

$$V_{out}(t) = L\frac{dI_L(t)}{dt} = \frac{1}{C}\int_0^t I_c(\tau)\,d\tau$$

KVL @ L1: $V_{in} - V_R - V_{out} = 0$

$$V_{in}(t) - V_R = V_{out}(t)$$

$$I_L = \int \frac{V_{out}(t)}{L}dt = \frac{V_{out}(s)}{Ls}$$

$$I_c = C\frac{dV_{out}(t)}{dt} = CsV_{out}(s)$$

$$V_{in}(t) - RI_R(t) = V_{out}(t)$$

$$\mathcal{L}\{V_{in}(t) - R(I_L + I_c)\} = \mathcal{L}\{V_{out}(t)\}$$

$$V_{in}(s) - R\left(\frac{V_{out}(s)}{Ls} + CsV_{out}(s)\right) = V_{out}(s)$$

$$V_{in}(s) = V_{out}(s) + R\left(\frac{V_{out}(s)}{Ls} + CsV_{out}(s)\right)$$

$$H(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{V_{out}(s)}{V_{out}(s)\left[1 + R\left(\frac{1}{Ls} + Cs\right)\right]} \cdot \left(\frac{Ls}{Ls}\right)$$

$$= \boxed{\frac{Ls}{Ls + R(1 + LCs^2)}}$$

$$= \frac{Ls}{RLCs^2 + Ls + R} = \frac{27\times10^{-3}s}{(1000)(27\times10^{-3})(100\times10^{-9})s^2 + 27\times10^{-3}s + 1000}$$

(or use complex roots) → (doesn't factor ∴ put into calc)

(Can't transform funct → '$\mathcal{L}$' able one)
'So use complex roots

(calculator)

② $h(t) = \mathcal{L}^{-1}\{H(s)\} = \boxed{10{,}000\, e^{-5000t}\left[\cos(18{,}584t) - 0.269\sin(18{,}584t)\right]}$

$$H(s) = \frac{27\times10^{-3}s}{2.7\times10^{-6}s^2 + 27\times10^{-3}s + 1000}$$

1) $p = \dfrac{-27\times10^{-3} \pm \sqrt{(27\times10^{-3})^2 - 4(2.7\times10^{-6})(1000)}}{2(2.7\times10^{-6})}$

$= -5000 + j18{,}584.14$

2) $H_0(s) = 27\times10^{-3}s \Big|_{s=p=-5000+j18584} = -135 + j501.8$

$= 519.615\angle 105.06^\circ$

3) $h_s(t) = \dfrac{519.615}{18{,}584.14} e^{-5000t} \sin(18{,}584.14t + 105.06^\circ)\, u(t)$

$= \boxed{0.02796\, e^{-5000t} \sin(18{,}584.14t + 105.06^\circ)\, u(t)}$