TI Exam ES 2 odd-2021

① $\alpha = \frac{1}{2RC} = 0.25 \Rightarrow \alpha^2 = .0625$

$\omega_0^2 = \frac{1}{LC} = 0.25 \quad \because \alpha^2 < \omega_0^2$ circuit is underdamped. — 0.5

— 0.5

② $\frac{dv(0)}{dt} = \frac{-v(0)}{RC} - \frac{i(0)}{C} = 8\ V/sec.$ — 0.5

— 0.5

③ $\frac{d^2v}{dt} + \frac{1}{RC}\frac{dv}{dt} + \frac{1}{LC}v = 0$ — 0.5

$s^2v + \frac{1}{RC}sv + \frac{1}{LC}v = 0$

$s^2 + 2s + 1 = 0$ — 0.5

④ $v(0^+) = v(0^-) = 0V$ — 1

⑤ $AD - BC = 1$ — 1

⑥ V_1, V_2 — 1

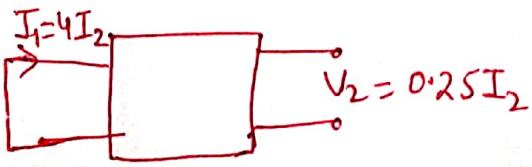
⑦ $\Delta Z = 41 \qquad Y_{12} = \frac{-Z_{12}}{\Delta Z} = \frac{-1}{41}$ — 0.5

— 0.5

⑧ $\Delta T = 5$

$Z = \begin{bmatrix} \frac{A}{C} & \frac{\Delta T}{C} \\ \frac{1}{C} & \frac{D}{C} \end{bmatrix}$ — 0.5

$\begin{bmatrix} 4 & 5 \\ 1 & 2 \end{bmatrix}$ — 0.5

⑨ 

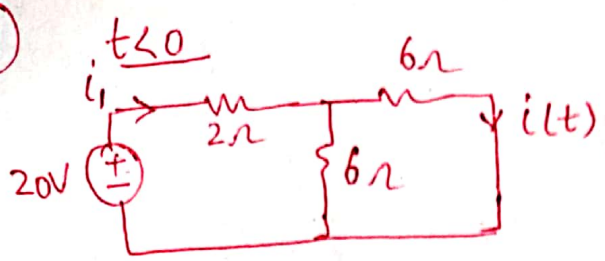
$Y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0} = 16$ — 0.5

— 0.5

PP1

(10) $N_a N_b$ ——— (1)

(11)

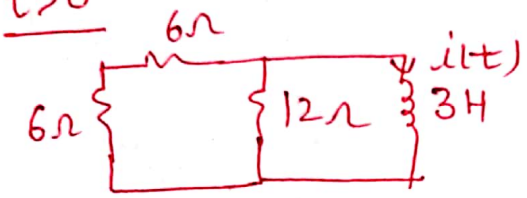


$i_1 = \frac{20}{2+3} = 4A$

$i(t) = \frac{4 \times 6}{6+6} = 2A$ at $t<0$

$i(0^-) = i(0^+) = 2A$ ——— 0.5 mark

t>0



$R_{eq} = 12 \| 12 = 6\Omega$

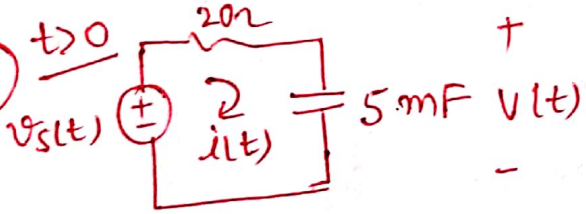
$\tau = \frac{L}{R_{eq}} = \frac{1}{2}$ Sec ——— 1 Mark

$i(\infty) = 0$ ——— 0.5 Mark

$i(t) = i(\infty) + [i(0^+) - i(\infty)]e^{-t/\tau}$

$= 2e^{-2t}$ ——— 1 Mark

(12) t>0



$\tau = RC = 20 \times 5 \times 10^{-3}$

$= 10^{-1}$

$v_s(t) = 20i(t) + v(t)$

$5\sin 10t = 20 \cdot C\frac{dv}{dt} + v(t)$

$\frac{dv}{dt} + 10v(t) = 50\sin 10t$ ——— (1)

Forced response $v_f(t) = B_1\cos 10t + B_2 \sin 10t$ must satisfy (1)

$-10B_1 + 10B_2 = 50$

$10B_1 + 10B_2 = 0$

$B_1 = -\frac{5}{2}, B_2 = \frac{5}{2}$ ——— 1 Mark

Complete response $v(t) = v_n(t) + v_f(t)$

$= Ae^{-t/\tau} + \left[-\frac{5}{2}\cos 10t + \frac{5}{2}\sin 10t\right]$

——— 1 Mark

PP2

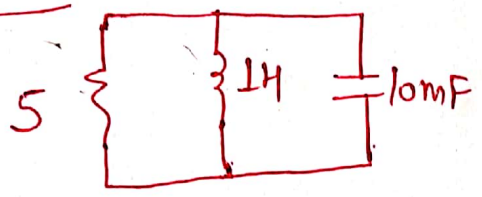
$V(t)|_{t=0} = 0$

$A - \frac{5}{2} = 0 \Rightarrow A = 5/2$

Complete response $V(t) = \frac{5}{2} e^{-10t} - \frac{5}{2}\cos 10t + \frac{5}{2}\sin 10t$

— 1 Mark

(13) $t > 0$



$\alpha = \frac{1}{2RC} = 10$ Critically damped.

$\omega_0 = \frac{1}{\sqrt{LC}} = 10$ — 0.5 Mark

$S_1 = -\alpha + j\sqrt{\omega_0^2 - \alpha^2}$, $S_2 = -\alpha - j\sqrt{\omega_0^2 - \alpha^2}$

$= -10$ $= -10$ equal roots — 1 Mark

natural response. $i_n(t) = (A + Bt)e^{-10t}$ — 0.5 Mark

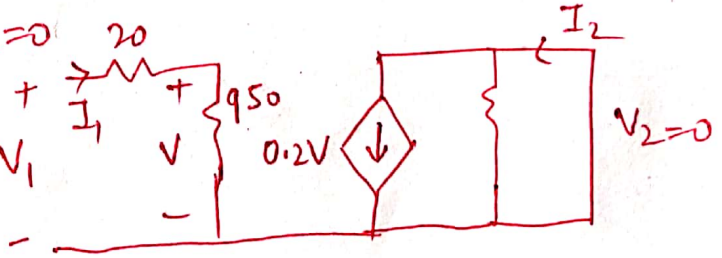
$\because i(0-) = i(0+) = 1A \Rightarrow A = 1$

$v_0(t) = L\frac{di}{dt} = Be^{-10t} + [-10(A+Bt)e^{-10t}]$

$\because v_0(t)|_0 = 0 \Rightarrow B = 10$

$i_n(t) = (1 + 10t)e^{-10t}$ — 1 Mark

(14) $V_2 = 0$



$I_2 = 0.2V$

$V = 950 I_1$

$\Rightarrow I_2 = 190 I_1$

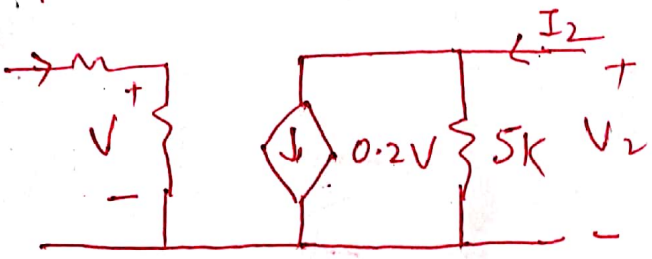
$h_{11} = \frac{V_1}{I_1}\Big|_{V_2=0} = \frac{(20+950)I_1}{I_1} = 970\Omega$

$h_{21} = \frac{I_2}{I_1}\Big|_{V_2=0} = 190$

— 1 Mark

PP3

$I_1 = 0 \Rightarrow V = 0$



$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} = 0$$

$$h_{22} = \left.\frac{I_2}{V_2}\right|_{I_1=0} = \frac{1}{5} = .2 \times 10^{-3}\ \mho$$ —— (1 Mark)