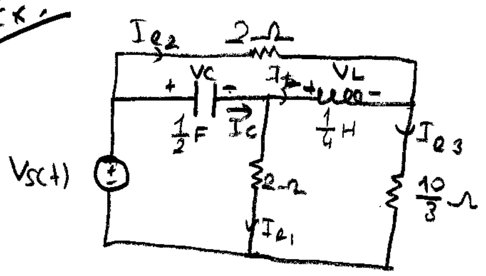
28.07.2010

Ex.



$V_c(0^-) = 3V$

$I_L(0^-) = 5A$

a) Find diff-equ for V_c and I_L.

b) If $V_s(t) = u(t)$ find Initial condition changes.

$V_c(0^+) = ?$ $I_L(0^+) = ?$ $\frac{dV_c}{dt}(0^+) = ?$ $\frac{dI_L}{dt}(0^+) = ?$ $\frac{dV_c}{dt}(0^-) = ?$ $\frac{dI_L}{dt}(0^-) = ?$

Soltn.

$I_C = I_L + I_{R1}$

$$\frac{1}{2}\frac{dV_c}{dt} = I_L + \frac{V_s - V_c}{2}$$

$$* \quad \frac{dV_c}{dt} = V_s + 2I_L - V_c$$

$I_{R3} = I_L + I_{R2}$

$$\frac{V_s - V_c - V_L}{\frac{10}{3}} = I_L + \frac{V_c + V_L}{2}$$

$$I_L + \frac{V_c}{2} + \frac{\frac{1}{4}\frac{dI_L}{dt}}{2} = \frac{3}{10}V_s - \frac{3}{10}V_c - \frac{3}{10\times 4}\frac{dI_L}{dt}$$

$$\left(\frac{1}{8} + \frac{3}{40}\right)\frac{dI_L}{dt} = \frac{3}{10}V_s - \left(\frac{1}{2} + \frac{3}{10}\right)V_c - I_L$$

$$\frac{1}{5}\frac{dI_L}{dt} = \frac{3}{10}V_s - \frac{4}{5}V_c - I_L$$

$$** \quad \frac{dI_L}{dt} = \frac{3}{2}V_s - 4V_c - 5I_L$$

$\frac{d}{dt}*$, put $**$ inside:

$$\frac{d^2V_c}{dt^2} = \frac{dV_s}{dt} + 2\frac{dI_L}{dt} - \frac{dV_c}{dt}$$

$$\frac{d^2V_c}{dt^2} + \frac{dV_c}{dt} = \frac{dV_s}{dt} + 2\left(\frac{3}{2}V_s - 4V_c - 5I_L\right)$$

$$\frac{d^2V_c}{dt^2} + \frac{dV_c}{dt} + 8V_c = \frac{dV_s}{dt} + 3V_s - 10I_L$$

$$= \frac{dV_s}{dt} + 3V_s - \left(5\frac{dV_c}{dt} + 5V_c - 5V_s\right)$$

$$\frac{d^2V_c}{dt^2} + 6\frac{dV_c}{dt} + 13V_c = \frac{dV_s}{dt} + 8V_s$$

$V_c(0^-) = 3$ $\quad \frac{dV_c}{dt}(0^-) = V_s(0^-) + 2I_L(0^-) - V_c(0^-)$

$= V_s(0^-) + 2\times 5 - 3 = V_s(0^-) + 7 \implies$

1-

$$\frac{d^2 I_L}{dt^2} = \frac{3}{2}\frac{dV_s}{dt} - 4\frac{dV_c}{dt} - 5\frac{dI_L}{dt}$$

$$\frac{d^2 I_L}{dt^2} + \frac{5\,dI_L}{dt} = \frac{3}{2}\frac{dV_s}{dt} - 4\,(V_s + 2I_L - V_c)$$

$$\frac{d^2 I_L}{dt^2} + \frac{5\,dI_L}{dt} + 8I_L = \frac{3}{2}\frac{dV_s}{dt} - 4V_s + 4V_c$$

$$4V_c = \frac{3}{2}V_s - 5I_L - \frac{dI_L}{dt}$$

$$\frac{d^2 I_L}{dt^2} + \frac{5\,dI_L}{dt} + 8I_L = \frac{3}{2}\frac{dV_s}{dt} - 4V_s + \frac{3}{2}V_s - 5I_L - \frac{dI_L}{dt}$$

$$\boxed{\frac{d^2 I_L}{dt^2} + 6\frac{dI_L}{dt} + 13\,I_L = \frac{3}{2}\frac{dV_s}{dt} - \frac{5}{2}V_s}$$

$$I_L(0^-) = 5$$

$$\frac{dI_L}{dt}(0^-) = \frac{3}{2}V_s(0^-) - 4V_c(0^-) - 5I_L(0^-)$$

$$= \frac{3}{2}V_s(0^-) - 4\times 3 - 5\times 5$$

$$= \frac{3}{2}V_s(0^-) - 37$$

b)

$$\frac{dV_c}{dt}(0^-) = V_s(0^-) + 7 = u(0^-) + 7 = 7$$

$$\frac{dI_L}{dt}(0^-) = \frac{3}{2}V_s(0^-) - 37 = \frac{3}{2}u(0^-) - 37 = -37$$

$$\int_{I_L(0^-)}^{I_L(0^+)} dI_L = \frac{3}{2}\int_{0^-}^{0^+} \underbrace{V_s(t')}_{u(t')}\,dt' - 4\int_{0^-}^{0^+} V_c(t')\,dt' - 5\int_{0^-}^{0^+} I_L(t')\,dt'$$

$$I_L(0^+) - I_L(0^-) = 0 - 0 - 0 \Rightarrow \boxed{I_L(0^+) = I_L(0^-) = -37}$$

$$\int_{V_c(0^-)}^{V_c(0^+)} dV_c = \int_{0^-}^{0^+} V_s(t')\,dt' - 2\int_{0^-}^{0^+} I_L(t')\,dt' - \int_{0^-}^{0^+} V_c(t')\,dt'$$

$$V_c(0^+) - V_c(0^-) = 0 + 0 - 0$$

$$\boxed{V_c(0^+) = V_c(0^-) = 7}$$

$\Longrightarrow$

$$\frac{dI_L}{dt}(0^+) = \frac{3}{2}\overset{u(0^+)}{V_s(0^+)} - 4V_c(0^+) - 5I_L(0^+)$$

$$= \frac{3}{2} - 4\times 3 - 5\times 5 = \frac{-71}{2}$$

$$\frac{dV_c}{dt}(0^+) = V_s(0^+) + 2I_L(0^+) - V_c(0^+)$$

$$= 1 + 2\times 5 - 3 = 8$$

$t>0$ $\rightarrow u(t) = 1$ $\frac{du(t)}{dt} = 0$ when $t>0$

$$\frac{d^2V_c}{dt^2} + \frac{6dV}{dt} + 13V_c = 8\underset{1}{V_s} + \underset{0}{\frac{dV_s}{dt}} = 8$$

$V_c(0^+) = 3V$ $\frac{dV_c}{dt}(0^+) = 8$

$$\frac{d^2I_L}{dt^2} + \frac{6dI_L}{dt} + 13I_L = -\frac{5}{2}\underset{1}{V_s} + \frac{1}{2}\underset{0}{\frac{dV_s}{dt}}$$

$$= -\frac{5}{2}$$

$I_L(0^+) = 5$ $\frac{dI_L}{dt}(0^+) = -\frac{7}{2}$

char eqn: $s^2 + 6s + 13$

$$s_{1,2} = \frac{-6 \pm \sqrt{36-52}}{2} = \frac{-6 \mp 4j}{2} = -3 \pm 2j$$

For I_L

① $I_{Lp} = K$

$$\frac{d^2K}{dt^2} + \frac{6d}{dt}K + 13K = \frac{-5}{2}$$

$$K = -\frac{5}{26}$$

$$I_L = -\frac{5}{26} + e^{-3t}\left[k_1\cos(2t) + k_2\sin(2t)\right]$$

$I_L(0^+) = 5$, $\frac{dI_L}{dt}(0^+) = -\frac{71}{2}$ HW.

For V_c

$V_{cp} = \mu$

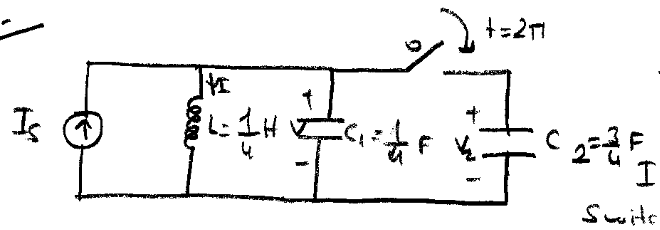
$$\frac{d^2\mu}{dt^2} + 6\frac{d}{dt}\mu + 13\mu = 8$$

$$\mu = \frac{8}{13}$$

$$V_c(t) = \frac{8}{13} + e^{-3t}\left[A_1\cos(2t) + A_2\sin(2t)\right]$$

$$V_c(0^+) = 3 \qquad \frac{dV_c}{dt}(0^+) = 8 \quad \ldots$$

Ex-



$I(0) = 0A \quad V(0) = 0A$

$V_2(0) = \frac{4}{3}V$

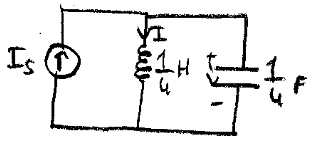
$I_s(t) = 1A$

Switch open when $0 < t < 2\pi$ and closed when $t > 2\pi$

Find $V(t)$, $I(t)$ when $t > 0$

Soltn

$0 < t < 2\pi$



$$I_s = I + I_{C_1}$$

$$I_s = I + C_1\frac{dV}{dt}$$

$$I_s = I + \frac{1}{4}\frac{dV}{dt}$$

$$\frac{dV}{dt} = 4I_s - 4I$$

$$** \boxed{\frac{dV}{dt} = 4 - 4I}$$

$$V = L\frac{dI}{dt}$$

$$V = \frac{1}{4}\frac{dI}{dt} \Rightarrow \boxed{\frac{dI}{dt} = 4V} \; *$$

$\Rightarrow$

$\frac{d}{dt}$ * , put ** inside ;

$$\frac{d^2I}{dt^2} = 4\frac{dV}{dt} = 4\ (4-4I)$$

$$\boxed{\frac{d^2I}{dt^2} + 16I = 16}$$

$I(0)=0,\ \frac{dI}{dt}(0) = 4V(0) = 0$

$\frac{d}{dt}$ ** , put * inside ;

$$\frac{d^2V}{dt^2} = -4\frac{dI}{dt} = -4\ (4V)$$

$$\boxed{\frac{d^2V}{dt^2} + 16V = 0}$$

$V(0)=0\quad \frac{dV}{dt}(0) = 4-4I(0) = 4$

Solve for I

$I_p = K$

$\frac{d^2}{dt^2}K + 16K = 16$

$K = 1$

Char eq $s^2+16=0 \Rightarrow s_{1,2} = \mp 4j$

$I(t) = I_p + I_h$

$= 1 + A_1\cos(4t) + A_2\sin(4t)$

$I(0)=0 = 1+A_1 \Rightarrow A_1 = -1$

$\frac{dI}{dt}(0) = 0$

$\frac{dI}{dt} = 0 - 4A_1\sin(4t) + 4A_2\cos(4t)$

$\frac{dI}{dt}(0) = 4A_2 = 0 \Rightarrow A_2 = 0$

$$\boxed{I(t) = 1 - \cos(4t)}$$

$\Longrightarrow$

Solve for V

$$L\frac{dI}{dt} = V$$

$$\frac{1}{4}\frac{d}{dt}\left[1-\cos(4t)\right] = V$$

$$V = \frac{1}{4}\left[0 + 4\sin(4t)\right] = \sin 4t$$

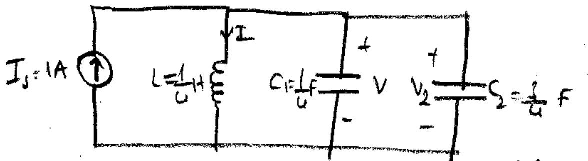
$$\boxed{V = \sin(4t)}$$

$t = 2\pi^-$

$$V(2\pi^-) = 0$$

$$I(2\pi^-) = 1-\cos(8\pi) = 0$$

$2\pi < t$ (switch closed)



$$V_2(2\pi) = V_2(0) = \frac{4}{3}$$

$$Q(2\pi^-) = Q(2\pi^+)$$

(preserve charge amount)

$$C_1 V(2\pi^-) + C_2 V_2(2\pi^-) = (C_1 + C_2)V(2\pi^+)$$

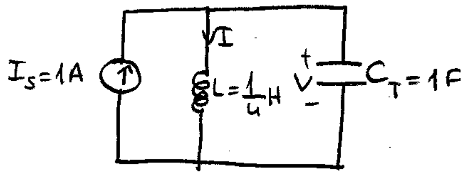
$$\frac{1}{4}\times 0 + \frac{3}{4}\times\frac{4}{3} = \left(\frac{1}{4}+\frac{3}{4}\right)V(2\pi^+)$$

$$V(2\pi^+) = 1\ V$$

$$I(2\pi^+) = I(2\pi^-) = 0A$$

$\Longrightarrow$

New equivalent circuit



$I(2\pi^+) = 0 \quad V(2\pi^+) = 1V$

$t > 2\pi$

$$\frac{d^2V}{dt^2} + \frac{1}{C_T L} V = \frac{1}{C_T} \frac{dI_s}{dt}$$

$$\boxed{\frac{d^2V}{dt^2} + 4V = 0}$$

$$\frac{d^2I}{dt^2} + \frac{1}{C_T L} I = \frac{1}{C_T L} I_s$$

$$\boxed{\frac{d^2I}{dt^2} + 4I = 4}$$

$I(2\pi^+) = 1A$

$$\frac{dI}{dt}(2\pi^+) = \frac{V(2\pi^+)}{L} = \frac{1}{1/4} = 4$$

$V(2\pi^+) = 1V$

$$\frac{dV}{dt}(2\pi^+) = \frac{I_s(2\pi) - I(2\pi^+)}{C_T} = \frac{1-0}{1} = 1$$

For I

$I_p = M$

$\frac{d^2}{dt^2} M + 4M = 4 \rightarrow M = 1$

$s^2 + 4 = 0 \rightarrow s_{1,2} = \mp 2j$

$I(t) = I_p + I_h$

$= 1 + A_1 \cos(2t) + A_2 \sin(2t)$

$I(2\pi^+) = 0 = 1 + A_1 \cos(4\pi^+) + A_2 \sin(4\pi)$

$0 = 1 + A_1 + 0 \quad \boxed{A_1 = -1}$

$\frac{dI}{dt}(2\pi^+) = 4$

$\frac{dI}{dt} = -2A_1 \sin(2t) + 2A_2 \cos(2t)$

$\frac{dI}{dt}(2\pi) = 2A_2 = 4$

$\boxed{A_2 = 2}$

$t > 2\pi$

$\boxed{I(t) = 1 - \cos(2t) + 2\sin(2t)}$

$L \frac{dI}{dt} = V(t)$

$V = \frac{2\sin(2t) + 4\cos(2t)}{4}$

$\boxed{V(t) = \frac{1}{2}\sin(2t) + \cos(2t)}$

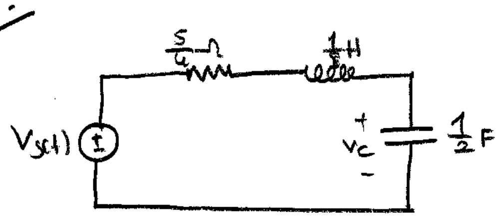
Result : $0 < t < 2\pi \Rightarrow v(t) = \sin(4t)$

$I(t) = 1 - \cos(4t)$

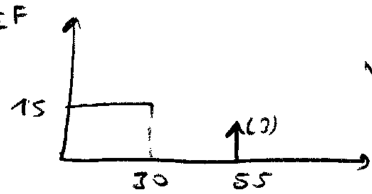
$t > 2\pi \Rightarrow v(t) = -\frac{1}{2}\sin(2t) + \cos(2t)$

$I(t) = -\frac{1}{2}\sin(2t) + \cos(2t)$

Ex.



$V_s(t) = 15[u(t) - u(t-30)] + 3\delta(t-55)$



$V_c(0^-) = 3V$

$I_L(0^-) = 0A$

Find $V_c(t)$ $t > 0$

Soltn.

1st Method

* Let $q(t)$ be unit step zero-state response

input $u(t) \longrightarrow$ output $q(t)$ initial condition $V_c(0^-)=0, I_L(0^-)=0$

** Let $h(t)$ be impulse zero-state response

input $\delta(t) \longrightarrow$ output $h(t)$ initial condition $V_c(0^-)=0, I_L(0^-)=0$

*** Let $V_{zi}(t)$ be the zero input response
(no input $V_s(t)=0$, but $V_c(0^-)=-3$, $I_L(0^-)=0$)

$$V_c(t) = 15\left[q(t)u(t) - q(t-30)u(t-30) + 3h(t-55)u(t-55) \right] + V_{zi}(t)$$

2nd Method

Inspect the input in different regions.

$$w_0^2 = \frac{1}{LC} = \frac{1}{\frac{1}{2} \times \frac{1}{8}} = 16 \qquad \alpha = \frac{R}{2L} = \frac{\frac{5}{4}}{2 \times \frac{1}{8}} = 5$$

$\Rightarrow$

$$\frac{d^2V_c}{dt^2} + 2\alpha \frac{dV_c}{dt} + \omega_o^2 V_c = \omega_o^2 V_s$$

$$\frac{d^2I_L}{dt} + 2\alpha \frac{dI_L}{dt} + \omega_o^2 I_L = \frac{1}{L} \frac{dV_s}{dt}$$

$\underline{0 < t < 30}$ $\Rightarrow V_s(t) = 15u(t)$

$$\frac{dV_c}{dt} = \frac{I_L}{C}, \quad \frac{dI_L}{dt} = \frac{V_s}{L} - \frac{V_c}{L} - \frac{I_L R}{L}$$

$V_c(0^-) = 3$, $I_L(0^-) = 0$

$$\frac{dV_c}{dt}(0^-) = \frac{I_L(0^-)}{C} = 0$$

$$\frac{dI_L}{dt}(0^-) = \frac{15u(0^-)}{L} - \frac{V_c(0^-)}{L} - \frac{I_L(0^-)R}{L}$$

$$= 0 - \frac{3}{\frac{1}{8}} - 0 = -24$$

$$\int_{V_c(0^-)}^{V_c(0^+)} dV_c = \frac{1}{C}\int_{0^-}^{0^+} I_L(t')dt'$$

$$V_c(0^+) - V_c(0^-) = 0$$

$V_c(0^+) = 3$,

$$\int_{I_L(0^-)}^{I_L(0^+)} dI_L = \frac{1}{L}\int_{0^-}^{0^+} \underbrace{V_s(t')}_{15u(t)}dt' - \frac{1}{L}\int_{0^-}^{0^+} V_c(t')dt' - \frac{R}{L}\int_{0^-}^{0^+} I_L(t')dt'$$

$$I_L(0^+) - I_L(0^-) = 0 - 0 - 0$$

$$I_L(0^+) = I_L(0^-) = 0$$

$$\frac{dV_c}{dt}(0^+) = \frac{I_L(0^+)}{C} = 0$$

$$\frac{dI_L}{dt}(0^+) = \frac{V_s(0^+)}{L} - \frac{V_c(0^+)}{L} - \frac{I_L(0^+)}{L}R$$

$$= \frac{15}{1/8} - \frac{3}{1/8} - \frac{0}{1/8} = 96$$

$0 < t < 30$

$$\frac{d^2V_c}{dt^2} + \underbrace{2\alpha}_{10} \frac{dV_c}{dt} + \underbrace{w_0^2}_{16} V_c = \underbrace{w_0^2}_{16} \; V_s = 240$$

$$V_c(0^+) = 3 \quad \frac{dV_c}{dt}(0^+) = 0$$

$$\frac{d^2I_L}{dt^2} + 10 \frac{dI_L}{dt} + 16 I_L = 8 \underbrace{\frac{dV_s}{dt}}_{0} = 0$$

$$I_L(0^+) = 0 \quad \frac{dI_L}{dt}(0^+) = 96$$

For V_c

$V_{cp} = K$

$$\frac{d^2}{dt^2} K + 10 \frac{d}{dt} K + 16K = 16 \times 15$$

$$K = 15$$

$$s^2 + 10s + 16 = 0 \implies s_{1,2} = -2, -8$$

$$V_c(t) = V_{cp} + V_{ch}$$

$$= 15 + A_1 e^{-2t} + A_2 e^{-8t}$$

$$V_c(0^+) = 3 = 15 + A_1 + A_2$$

$$A_1 + A_2 = -12$$

$$\frac{dV_c}{dt}(0^+) = 0 = -2A_1 - 8A_2$$

$$\left.\begin{aligned} A_1 + A_2 &= -12 \\ -2A_1 - 8A_2 &= 0 \end{aligned}\right\}$$

$$A_2 = 4$$

$$A_1 = -16$$

$$V_c(t) = 15 - 16e^{-2t} + 4e^{-8t}$$

$$C\frac{dV_c}{dt} = I_L = \frac{1}{2}\left[\frac{d}{dt}(15 - 16e^{-2t} + 4e^{-8t})\right]$$

$$= \frac{1}{2}\left[0 + 32e^{-2t} - 32e^{-8t}\right]$$

$$= 16e^{-2t} - 16e^{-8t}$$

$$V_c(30^-) \cong 15$$

$$I_L(30^-) = 0$$

$\Longrightarrow$

$30 < t < 55$

$$\frac{dV_c}{dt}(30^-) = \frac{I_L(30^-)}{C} = 0$$

$$\frac{dI_L}{dt}(30^-) = \frac{V_s(30^-)}{L} - \frac{V_c(30^-)}{L} - \frac{R}{L} I_L(30^-)$$

$$= \frac{15}{1/8} - \frac{15}{1/8} - 0 = 0$$

$$\frac{dV_c}{dt} = \frac{I_L}{L}$$

integrate at $t = 30$

$$\int_{V_c(30^-)}^{V_c(30^+)} dV_c = \frac{1}{L} \int_{30^-}^{30^+} I_L(t')dt'$$

$$V_c(30^+) = V_L(30^-) = 15$$

$$\frac{dI_L}{dt} = \frac{V_s}{L} - \frac{V_c}{L} - \frac{R}{L} I_L$$

integrate

$$\int_{I_L(30^-)}^{I_L(30^+)} dI_L = \frac{1}{L}\int_{30^-}^{30^+} V_s(t')dt' - \frac{1}{L}\int_{30^-}^{30^+} V_c(t')dt' - \frac{R}{L}\int_{30^-}^{30^+} I_L(t')dt'$$

$$I_L(30^+) - I_L(30^-) = 0 - 0 - 0$$

$$I_L(30^+) = I_L(30^-) = 0$$

$$\frac{dV_c}{dt}(30^+) = \frac{I_L(30^+)}{L} = 0$$

$$\frac{dI_L}{dt}(30^+) = \frac{1}{L} V_s(30^+) - \frac{1}{L} V_c(30^+) - \frac{R}{L} I_L(30^+)$$

$$= 0 - \frac{1}{1/8} 15 - 0 = -120$$

$$\frac{d^2V_c}{dt^2} + 10\frac{dV_c}{dt} + 16V_c = 16 \times 0 = 0$$

$$V_c(30^+) = 15 \qquad \frac{dV_c}{dt}(30^+) = 0$$

$$\frac{d^2I_L}{dt^2} + 10\frac{dI_L}{dt} + 16 I_L = \frac{1}{1/8}\frac{d}{dt}\left(-15\,u(t-30)\right)$$

$$= 8\left(-15\,\delta(t-30)\right)$$

$= 0$ when $t > 30$ $\Longrightarrow$

$I_L(30^+) = 0 \quad \frac{dI_L}{dt}(30^+) = -120$

for Vc

$V_{cp} = 0$

$s^2 + 10s + 16 = 0 \rightarrow s_{1,2} = -2, -8$

$V_c = V_{cp} + V_{ch}$

$= 0 + A_1 e^{-2(t-30)} + A_2 e^{-8(t-30)}$

$V_c(30^+) = 15 = A_1 + A_2$

$\frac{dV_c}{dt}(30^+) = 0 = -2A_1 - 8A_2 \qquad A_2 = -5 \quad A_1 = 20$

$V_c(t) = 20 e^{-2(t-30)} - 5 e^{-8(t-30)}$

$C\frac{dV_c}{dt} = I_L = \frac{1}{2}\left(\frac{d}{dt}\left(20 e^{-2(t-30)} - 5 e^{-8(t-30)}\right)\right)$

$= -20 e^{-2(t-30)} + 20 e^{-8(t-30)}$

$V_c(55^-) \cong 0 \quad I_L(55^-) \cong 0$

$\frac{dV_c}{dt}(55^-) \cong 0 \quad \frac{dI_L}{dt}(55^-) = 0$

$t > 55$

$$\int_{V_c(55^-)}^{V_c(55^+)} dV_c = \frac{1}{C}\int_{55^-}^{55^+} I_c(t')dt'$$

$V_c(55^+) - V_c(55^-) = 0 \Rightarrow V_c(55^+) = V_c(55^-) = 0$

$$\int_{I_L(55^-)}^{I_L(55^+)} dI_L = \frac{1}{L}\int_{55^-}^{55^+} \underbrace{V_s(t')}_{3\delta(t)}dt' - \frac{1}{L}\int_{55^-}^{55^+} V_c(t')dt' - \frac{R}{L}\int_{55^-}^{55^+} I_L(t')dt'$$

$I_L(55^+) - I_L(55^-) = \frac{1}{1/8} \times 3 = 24 \Rightarrow I_L(55^+) = 24$

$\frac{dV_c}{dt}(55^+) = \frac{I_L(55^+)}{C} = \frac{24}{1/2} = 48$

$3\delta(t-55)$

$\frac{dI_L}{dt}(55^+) = \frac{V_s(55^+)}{L} - \frac{V_c(55^+)}{L} - \frac{R}{L} I_L(55^+)$

$= 0 - 0 - \frac{5/4}{1/8} 24 = -240$ $\Longrightarrow$

$t > 5s \quad (V_s(t) = 3\,\delta(t-5) \rightarrow V_s(t) = 0 \quad t > 5s)$

$$\frac{d^2V_c}{dt^2} + 10\frac{dV_c}{dt} + 16V_c = 0$$

$V_c(5s^+) = 0 \qquad \frac{dV_c}{dt}(5s^+) = 48$

$V_{cp} = 0 \qquad s^2 + 10s + 16 = 0 \Rightarrow s_{1,2} = -2, -8$

$V_c = V_{cp} + V_{ch}$

$= 0 + k_1 e^{-2(t-5s)} + k_2 e^{-8(t-5s)}$

$V_c(5s^+) = 0 = k_1 + k_2$

$\frac{dV_c}{dt}(5s^+) = 48 = -2k_1 - 8k_2 \qquad k_1 = 8, \quad k_2 = -8$

$V_c(t) = 8e^{-2(t-5s)} - 8e^{-8(t-5s)}$

$C\frac{dV_c}{dt} = I_L = \frac{1}{2}\left[\frac{d}{dt}\left(8e^{2(t-5s)} - 8e^{-8(t-5s)}\right)\right]$

$I_L = -8e^{-2(t-5s)} + 32e^{-8(t-5s)}$