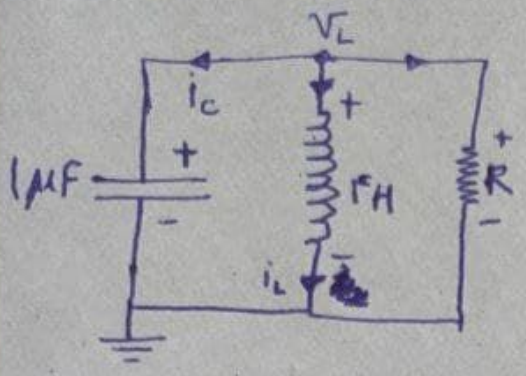
۲)



$$i_C + i_L + \frac{V_C}{R} = 0$$

$$\Rightarrow 4\times10^{-6} i_L'' + i_L + \frac{4 i_L'}{R} = 0$$

$$\Rightarrow 4\times10^{-6} s^2 + \frac{4s}{R} + 1 = 0 \rightarrow \Delta = 0$$

حالی داریم: $R = 1000\ \Omega \Rightarrow S = -500 \Rightarrow I_L(t) = e^{-500t}(A_1 t + A_2)$

در زمان $t<0$:

$$KCL: \frac{V}{1000} - 0.05 + \frac{V}{250} = 0 \Rightarrow V = 100\ V$$

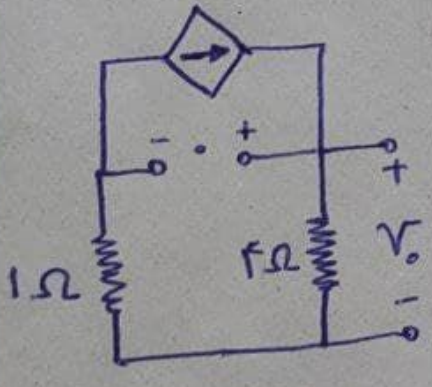
$$\Rightarrow I_L(0^-) = 0.2\ A \ , \ V_C(0^-) = 100\ V$$

همچنین: $I_L'(0^+) = \frac{V_L(0^+)}{4} = \frac{V_C(0^+)}{4} = \frac{100}{4} = 25$

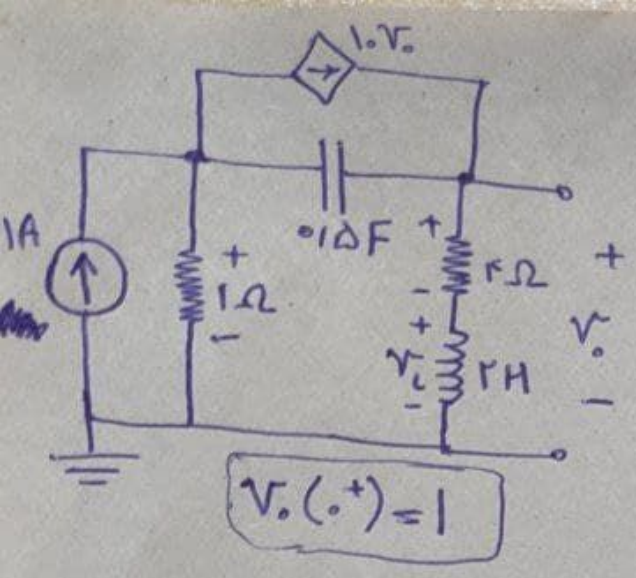
$$I_L(0^-) = 0.2 \Rightarrow A_1 = 0.2 \ , \ I_L'(0^+) = 25 \Rightarrow -500\times0.2 + A_1 = 25 \rightarrow A_1 = 225$$

$$\Rightarrow I_L(t) = \begin{cases} 0.2 & ; t<0 \\ e^{-500t}(225t + 0.2) & ; t>0 \end{cases}$$

۳) هنگامی که t به صفر از چپ میل می‌کند:



$$\rightarrow V_C(0^-) = 0 \ , \ i_L(0^-) = 0$$



$V_0(0^+) = 1$

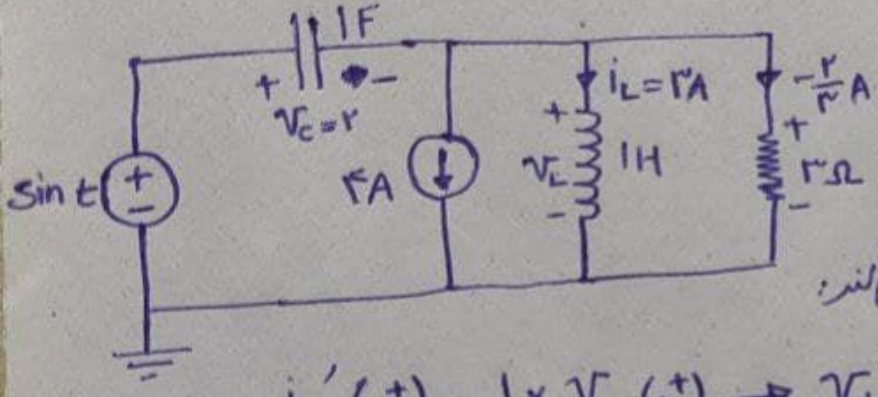
هنگامی که t به صفر از راست میل می‌کند:

$$i_L'(0^+) = \frac{V_L(0^+)}{2} \rightarrow i_L''(0^+) = \frac{V_L'(0^+)}{2}$$

KVL: $1 + V_C(0^+) - i_L(0^+) - V_L(0^+) - 4i_L(0^+) = 0 \Rightarrow V_C'(0^+) - 5i_L'(0^+) = V_L'(0^+)$

$\Rightarrow V_L'(0^+) = 20 - 2{,}5 = 17{,}5$

$$\rightarrow \frac{d^2 I_L}{dt^2}(0^+) = \frac{1}{2} \times 17{,}5 = 8{,}75$$



۴)

هنگامی که t به صفر از راست میل می‌کند:

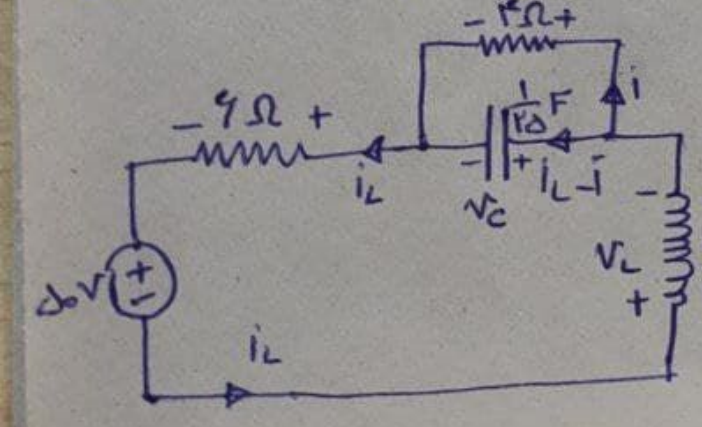
$$i_L'(0^+) = 1 \times V_L(0^+) \rightarrow V_L'(0^+) = i_L''(0^+)$$

همچنین: $V_L(0^+) = \sin t - V_C \Rightarrow V_L'(0^+) = \cos t - V_C'(0^+) = \cos t - i_L$

$$= -6 + \frac{2}{3} = \frac{-16}{3} \Rightarrow \frac{d^2 I_L}{dt^2}(0^+) = -\frac{16}{3}$$

۵) هنگامی که t به صفر از چپ میل می‌کند:

$V_C(0^-) = V_C(0^+) = 0$, $i_L(0^-) = i_L(0^+) = 0$



در زمان $t > 0$:

KVL: $50 + \frac{i_L'}{4} + V_C + 6i_L = 0$

KVL: $4i - V_C = 0$

$i_L - i = i_C = \frac{1}{25} V_C'$, $V_L = \frac{1}{4} i_L'$

$$\Rightarrow i_L = \frac{4i' + 25i}{25} \Rightarrow i_L' = \frac{4i'' + 25i'}{25}$$

با استفاده از معادله گسست داریم: $\frac{4i'' + 25i'}{100} + 4i + \frac{6(4i' + 25i)}{25} + 50 = 0$

$$\Rightarrow 4i'' + 121i' + 1000i = -5000$$

حل معادله مشخصه: $4s^2 + 121s + 1000 = 0 \rightarrow \Delta = -1359$

$$\Rightarrow s = -15{,}125 \pm 4{,}9j$$

$$i_n = e^{-15{,}125t}\left(A\cos(4{,}9t) + B\sin(4{,}9t)\right)$$

همچنین: $1000\, i_f = -5000 \Rightarrow i_f = -5$

$$i(t) = e^{-15{,}125t}\left(A\cos(4{,}9t) + B\sin(4{,}9t)\right) - 5$$

می‌توان نوشت:

$$i(0^+) = \frac{v_c(0^+)}{4} = 0\,,\quad i'(0^+) = \frac{v_c'(0^+)}{4} = \frac{25}{4} \times i_c(0^+) = 0$$

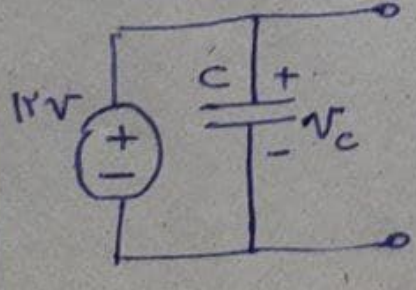
بنابراین:

$$A - 5 = 0 \Rightarrow A = 5$$

$$\curvearrowleft -15{,}125 \times 5 + 4{,}9B = 0 \Rightarrow B = 14{,}44$$

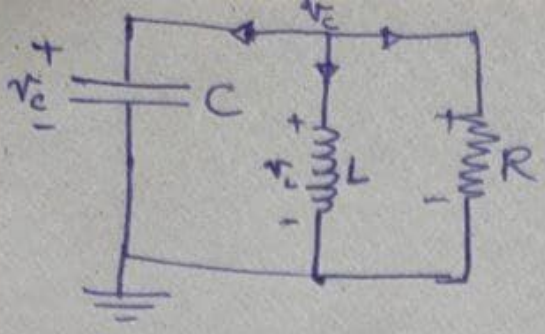
$$t > 0 \text{ جواب زمان: } i(t) = e^{-15{,}125t}\left(5\cos(4{,}9t) + 14{,}44\sin(4{,}9t)\right)$$

۶) هنگامی که t به صفر از چپ میل می‌کند:



$$v_c(0^-) = v_c(0^+) = 12\,V$$

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



در زمان $t>0$:

KCL: $\frac{v_c}{R} + i_L + i_c = 0$

$\Rightarrow \frac{v_c}{R} + i_L + v_c' C = 0$

$\Rightarrow \frac{v_c'}{R} + \frac{v_L}{L} + v_c'' C = 0$, می‌دانیم: $v_c = v_L$

$\Rightarrow Cs^2 + \frac{1}{R}s + \frac{1}{L} = 0 \rightarrow \Delta = -\frac{19}{9}$

$\Rightarrow s = -5 \pm 21{,}79\,j \Rightarrow v_c(t) = e^{-5t}\left(A\cos(21{,}79t) + B\sin(21{,}79t)\right)$

هنگامی که t به صفر از راست میل می‌کند:

$v_c(0^+) = 12 \Rightarrow v_c'(0^+) = 30 \times i_L(0^+)$

KCL: $\frac{v_c(0^+)}{3} + i_L(0^+) + i_c(0^+) = 0 \Rightarrow i_c(0^+) = -4\,A$

همچنین: $v_c'(0^+) = -120$, $\Rightarrow A = 12$

$\rightarrow -5 \times 12 + 21{,}79B = -120 \Rightarrow B = -2{,}75$

$v_c(t) = e^{-5t}\left(12\cos(21{,}79t) - 2{,}75\sin(21{,}79t)\right) \Rightarrow v_c'(t) = 0$

$\Rightarrow e^{-5t}\left(-247{,}73\sin(21{,}79t) - 119{,}82\cos(21{,}79t)\right) = 0$

مطلوبست: $\tan(21{,}79t) = -0{,}483 \Rightarrow t \simeq 0{,}123\,s$