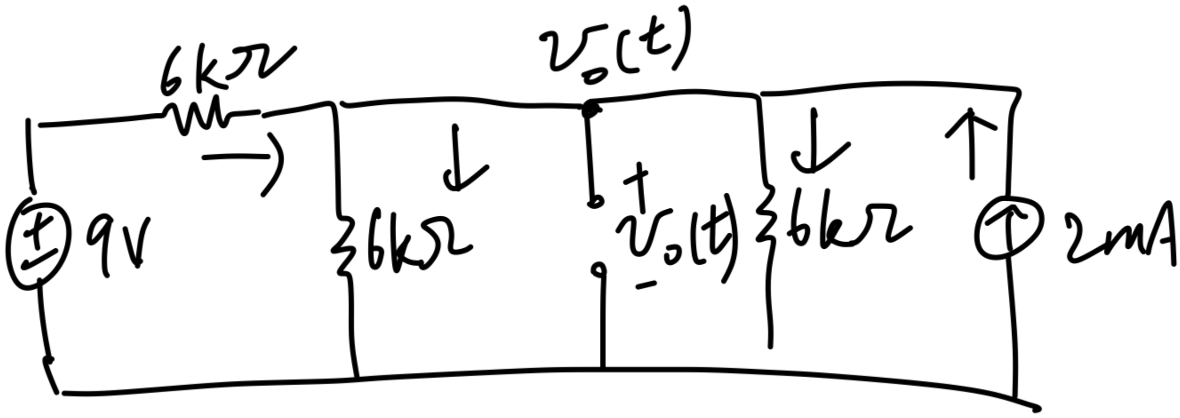
1.

$t = 0^-$

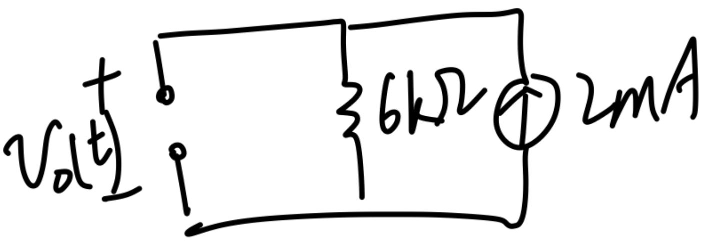


$$\frac{9 - v_o(t)}{6k} + 2m = \frac{v_o(t)}{3k}$$

$\Rightarrow v_o(0^-) = 7\ V$

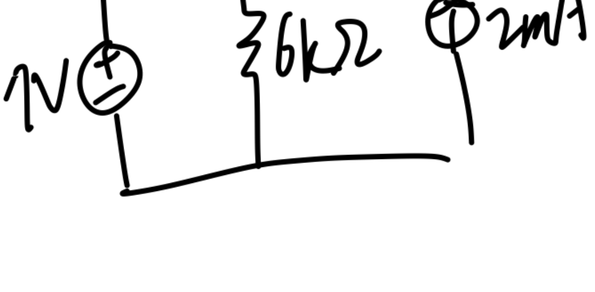
$$v_o(t) = K_1 + K_2 e^{-\frac{t}{2}}$$

$t = \infty$



$$v_o(\infty) = 2m \times 6k$$
$$= 12V$$
$$= K_1$$

$t = 0^+$



$$v_o(0^+) = K_1 + K_2$$

$$7 = 12 + K_2$$

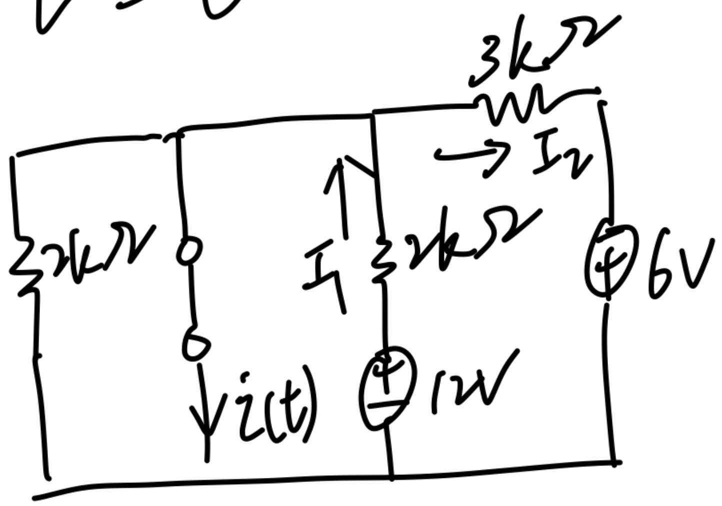
$$K_2 = -5$$

$\tau = RC = 6k \times 2.5\mu = 15m$

$v_o(t) = 12 - 5e^{-\frac{t}{15m}}$ (V)

2.

$t = 0^-$



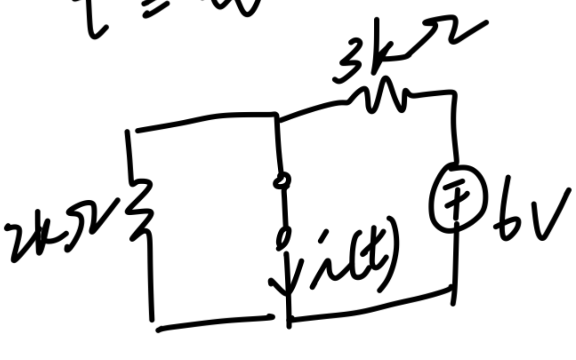
$i(0^-) = I_1 + I_2$

$= \frac{12}{6k} + \frac{6}{3k}$

$= 4mA$

$i(t) = K_1 + K_2 e^{-\frac{t}{2}}$

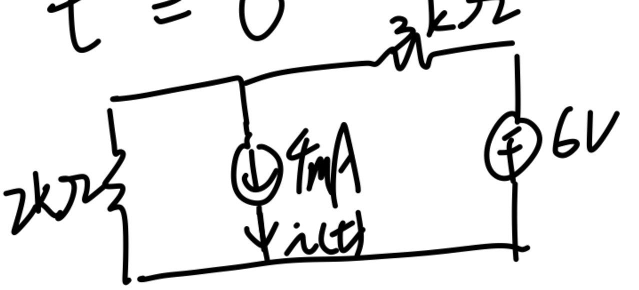
$t = \infty$



$i(\infty) = \frac{-6}{3k} = -2mA$

$= K_1$

$t = 0^+$



$i(0^+) = K_1 + K_2$

$\Rightarrow 4m = -2m + K_2$

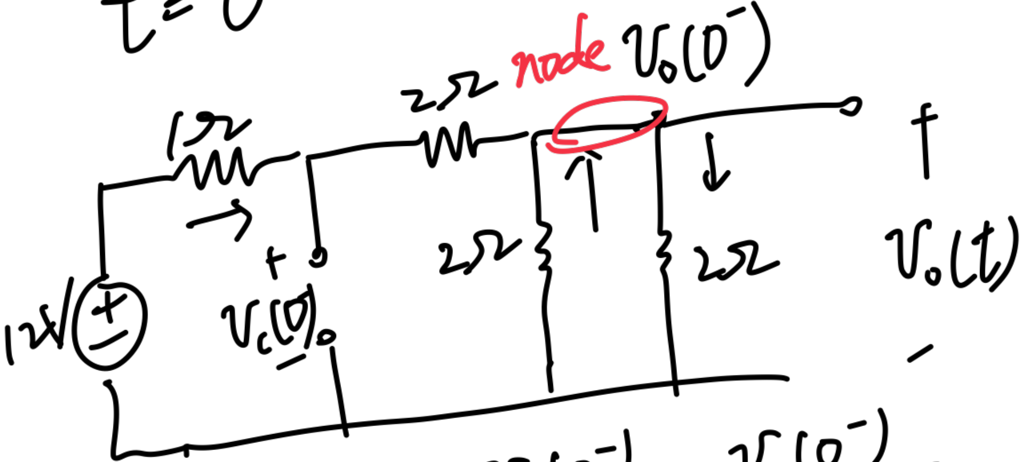
$\Rightarrow K_2 = 6m$

$$\tau = \frac{L}{R} = \frac{6m}{2k//3k} = 5\mu$$

$$i(t) = -2m + 6m\, e^{-\frac{t}{5\mu}} \ (A)$$

3.

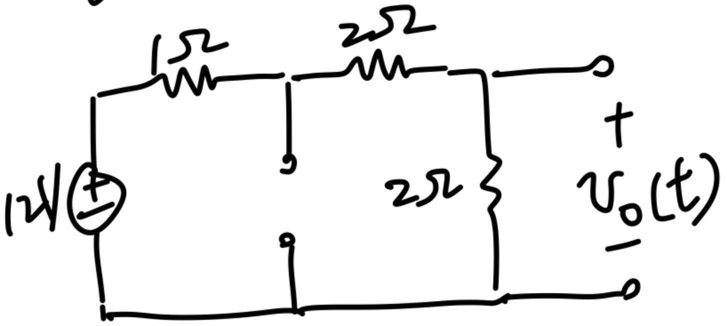
$t = 0^-$



$$\frac{12 - v_o(0^-)}{3} + \frac{v_o(0^-)}{2} = \frac{v_o(0^-)}{2} \Rightarrow v_o(0^-) = 6V$$

$$v_c(0^-) = \left(\frac{12 - v_o(0^-)}{1+2}\right) \times 2 + v_o(0^-) = 10\ V$$

$t = \infty$

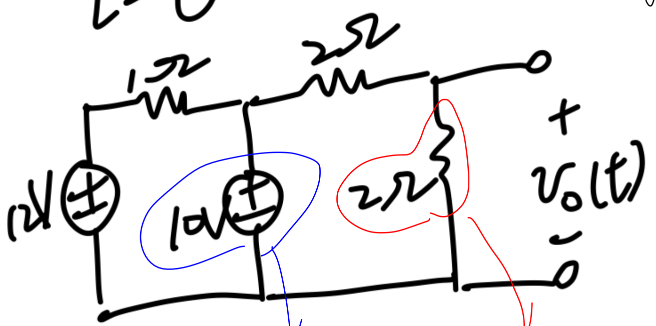


$$v_o(t) = K_1 + K_2 e^{-\frac{t}{2}}$$

$$v_o(\infty) = K_1$$

$$= 12 \times \frac{2}{5} = \frac{24}{5}\ V$$

$t=0^+$



電容跨壓 $v_c(0^-)=v_c(0^+)$

電阻跨壓 $v_o(0^-)\neq v_o(0^+)$

$v_o(0^-)\neq$ $v_o(0^+)=K_1+K_2$

又 $v_o(0^+)=10\times\frac{2}{2+2}=5V$

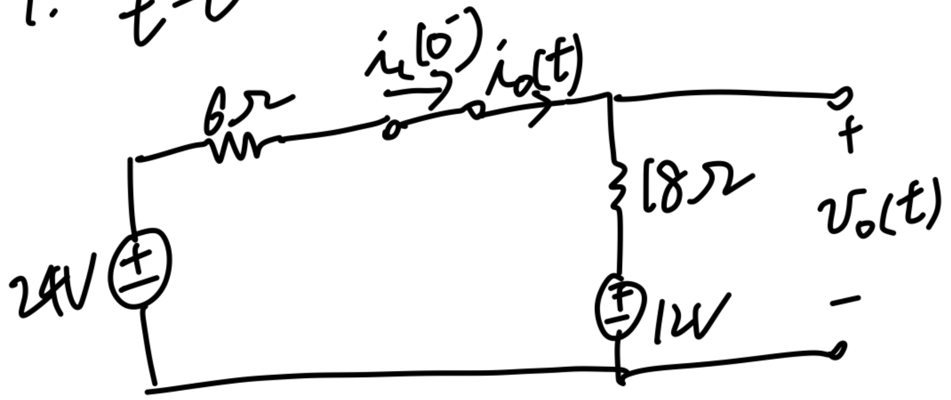
$\Rightarrow 5=K_1+K_2$

$\Rightarrow K_2=\frac{1}{5}$

$$\tau=RC=[1\,//\,(2+2)]\times 2=\frac{8}{5}$$

$$\underline{v_o(t)=\frac{24}{5}+\frac{1}{5}e^{-\frac{5}{8}t}\ V}$$

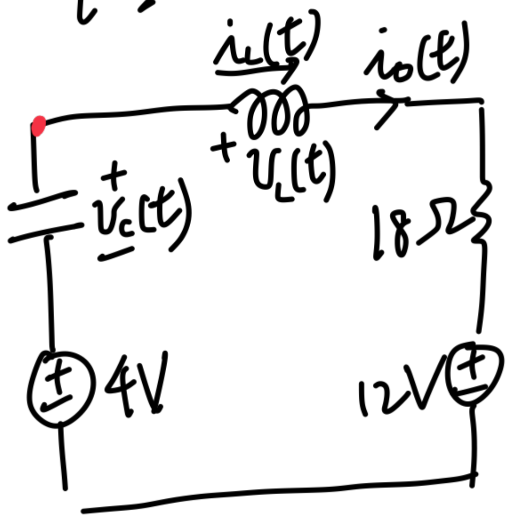
4. $t=0^-$



$$i_L(0^-)=i_o(0^-)=\frac{24-12}{24}=0.5A$$

$$v_o(0^-)=0.5\times18+12=21\ V$$

$t > 0$



KVL

$$4 + v_c(t) = v_L(t) + i_o(t)\times 18 + 12$$

$$\Rightarrow 4 + \frac{1}{C}\int -i_o(t)\,dt = L\frac{di_o(t)}{dt} + 18 i_o(t) + 12$$

兩邊微分

$$\Rightarrow -\frac{i_o(t)}{C} = L\frac{d^2 i_o(t)}{dt^2} + 18\frac{di_o(t)}{dt}$$

$$\Rightarrow \frac{d^2 i_o(t)}{dt^2} + \frac{R}{L}\frac{di_o(t)}{dt} + \frac{1}{LC} i_o(t) = 0$$

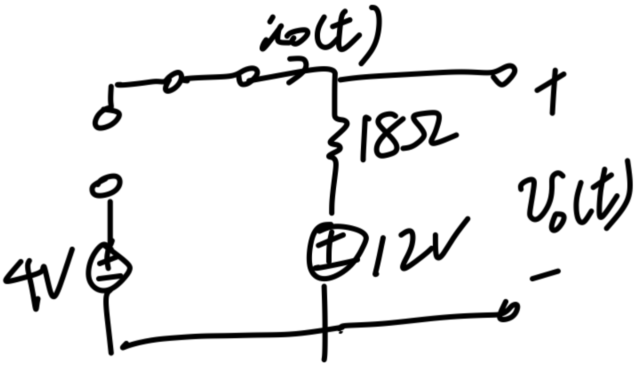
$$\Rightarrow s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$$

$$\Rightarrow s^2 + 9s + 18 = 0$$

$$s = -3, -6$$

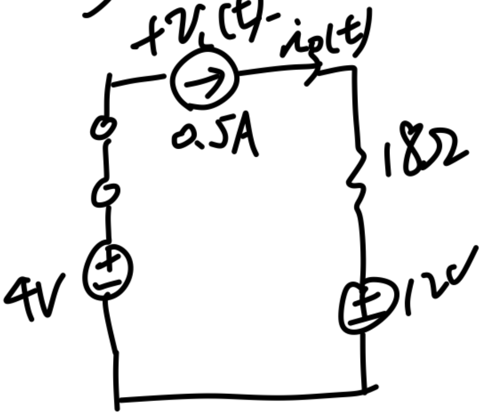
$$i_o(t) = K_1 e^{-3t} + K_2 e^{-6t} + K_3$$

$t = \infty$



$i_o(\infty) = K_3 = 0 \text{ A}$

$t = 0^+$



$i_o(0^+) = K_1 + K_2 + K_3 = 0.5 \text{ A}$

$\Rightarrow K_1 + K_2 = 0.5$ — ①

微分 $i_o(t)$

$\Rightarrow \dfrac{di_o(t)}{dt} = -3K_1 e^{-3t} - 6K_2 e^{-6t}$

$t=0$ 代入

$\Rightarrow \dfrac{di_o(0)}{dt} = -3K_1 - 6K_2$ — ②

而 $v_L(t) = L\dfrac{di_L(t)}{dt} = L\dfrac{di_o(t)}{dt}$ $(\because i_L(t) = i_o(t))$

$t=0$ 代入

$4 - (18 \times 0.5 + 12) = 2 \times \dfrac{di_o(0)}{dt}$

$\Rightarrow \dfrac{di_o(0)}{dt} = -8.5$ 代入②式

$-3K_1 - 6K_2 = -8.5$ — ③

①③式聯立

得 $K_1 = -\frac{11}{6}$, $K_2 = \frac{14}{6}$

$i_o(t) = -\frac{11}{6}e^{-3t} + \frac{14}{6}e^{-6t}$ (A)

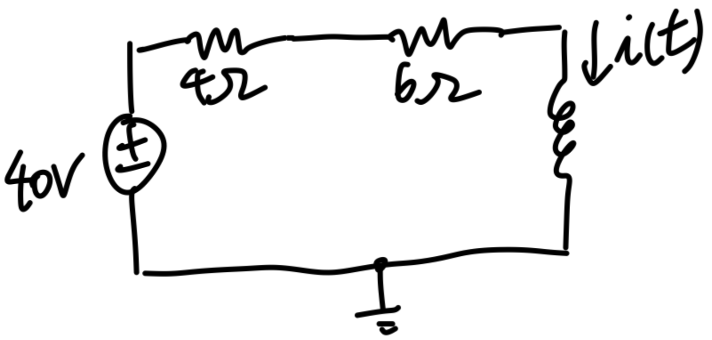
$v_o(t) = 12 + 18 i_o(t)$ (V)

---

5. $t < 0$

$i(0^-) = 0$ A

$0 \le t \le 4$ s



Assuming S_1 on, S_2 off forever

$$i(t) = K_1 + K_2 e^{-\frac{t}{\tau_1}} \quad , 0 \le t \le 4s$$

$$i(\infty) = K_1 = \frac{40}{4+6} = 4 (A)$$

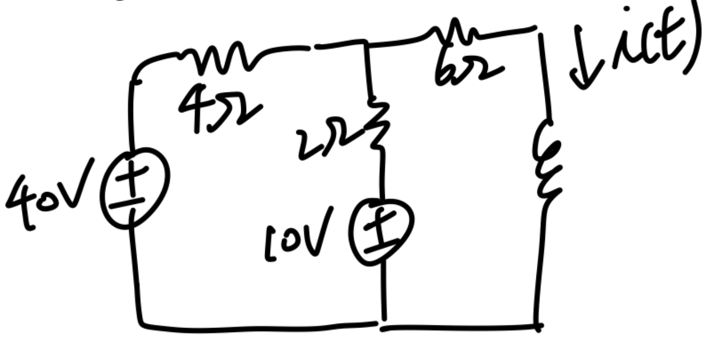
$$i(0) = K_1 + K_2 = 0 \ (A)$$

$$K_2 = -4$$

$$\tau_1 = \frac{L}{R} = \frac{5}{4+6} = \frac{1}{2}$$

$$i(t) = 4(1 - e^{-2t}) \ A \quad , 0 \le t \le 4s$$

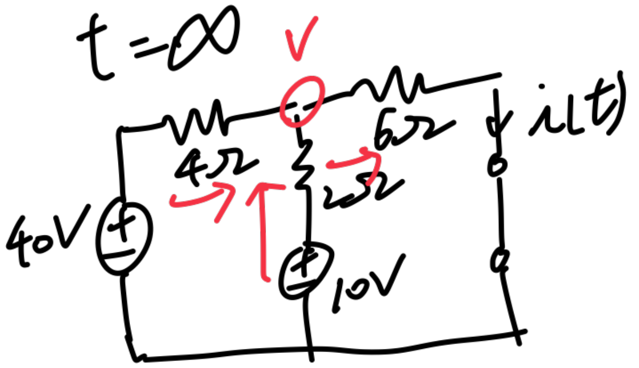
$t > 4s$



$$i(4) = 4(1 - e^{-8}) \simeq 4 \ A$$

$$i(t) = K_3 + K_4 e^{-\frac{t-4}{\tau_2}} \quad , t > 4s$$

$t=\infty$



$$\frac{40-V}{4}+\frac{10-V}{2}=\frac{V}{6} \Rightarrow V=\frac{180}{11}$$

$$i(\infty)=\frac{V}{6}=2.727\ A=K_3$$

$$i(4)=K_3+K_4=4$$

$$K_4=1.273$$

$$\tau_2=\frac{L}{R}=\frac{5}{6+(4\|2)}=\frac{15}{22}$$

$$i(t)=2.727+1.273e^{-\frac{22}{15}(t-4)}\ A,\quad t>4s$$

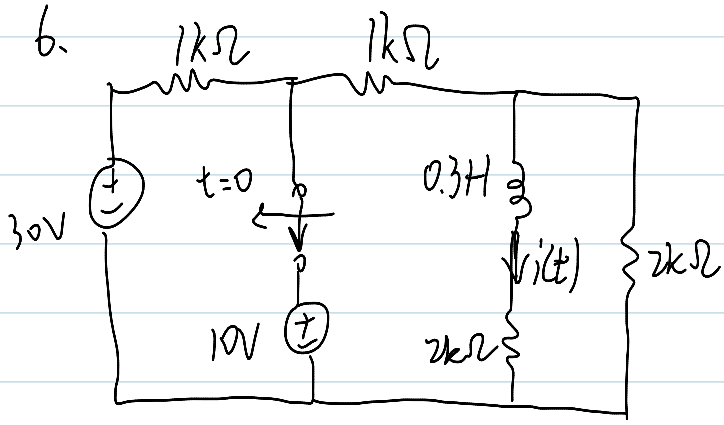
At $t=2s$

$$i(2)=4(1-e^{-4})=3.93A$$

At $t=5s$

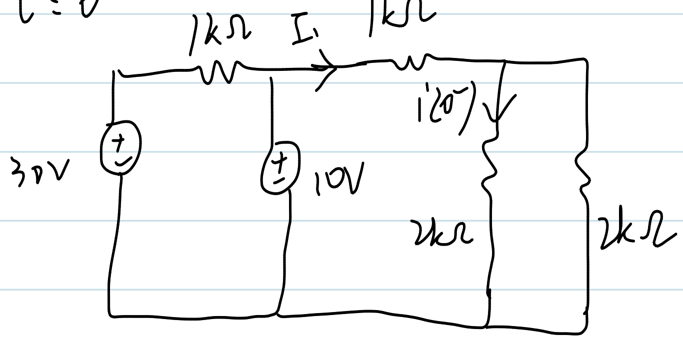
$$i(5)=2.727+1.273e^{-\frac{22}{15}}=3.02A$$

6.



$$i(t) = k_1 + k_2 e^{-t/\tau}$$

$t = 0^-$

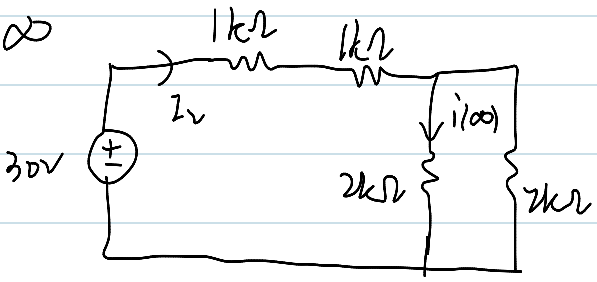


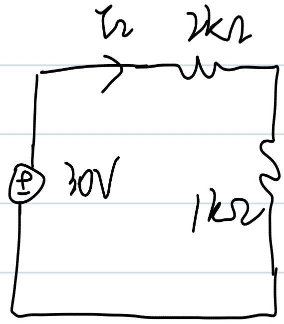
$$I_1 = \frac{10}{1k + (2k // 2k)} = 5 (mA)$$

$$i(0^-) = 5m \left(\frac{2k}{2k + 2k} \right) = 2.5 (mA)$$

$t = 0^+$ $\quad i(0^-) = i(0^+) = 2.5 (mA)$

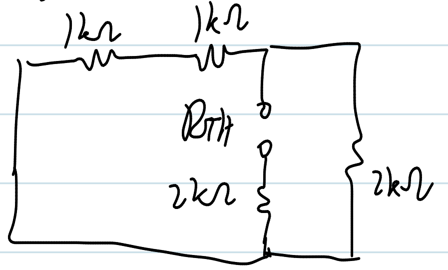
$t = \infty$

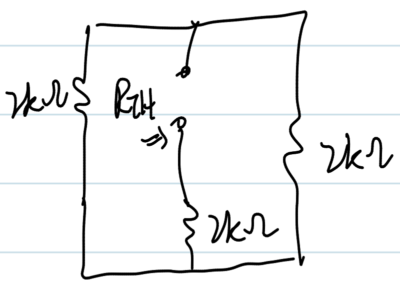




$$I_2 = \frac{30}{2k + 1k} = 10 (mA) \qquad i(\infty) = 10m \left(\frac{2k}{2k + 2k} \right) = 5 (mA)$$

find τ





$$R_{TH} = 2k + (2k // 2k) = 3 k\Omega$$

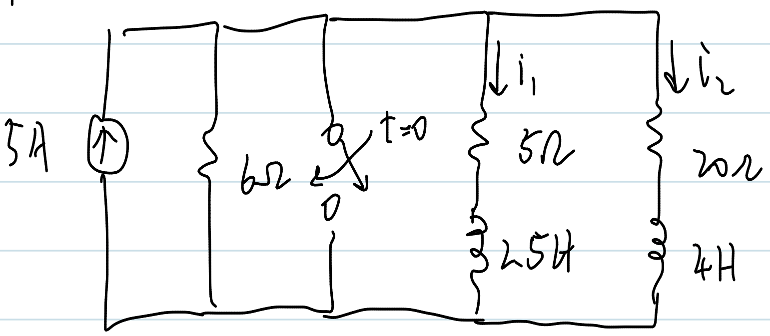
$$\tau = \frac{L}{R_{TH}} = \frac{0.3}{3 \times 10^3} = 10^{-4} (s)$$

$$i(t) = k_1 + k_2 e^{-t/\tau}, \quad i(\infty) = 5 (mA) = k_1$$

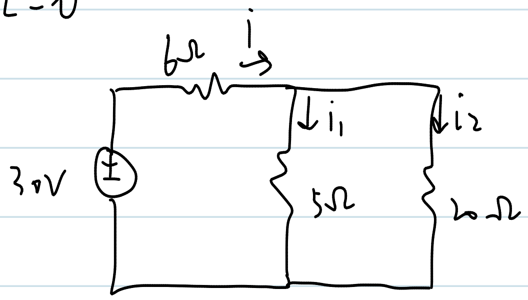
$$i(0^+) = 2.5m = k_1 + k_2, \quad k_2 = -2.5 (mA)$$

$$i(t) = 5 - 2.5 e^{-t/10^{-4}} (mA), \quad t > 0 \quad \#$$

7.



at $t=0^-$



$$i = \frac{30}{6+5\|20} = \frac{30}{10} = 3$$

$$i_1 = \frac{20}{25}(3) = 2.4\,(A), \quad i_2 = 0.6\,(A)$$

$t > 0$

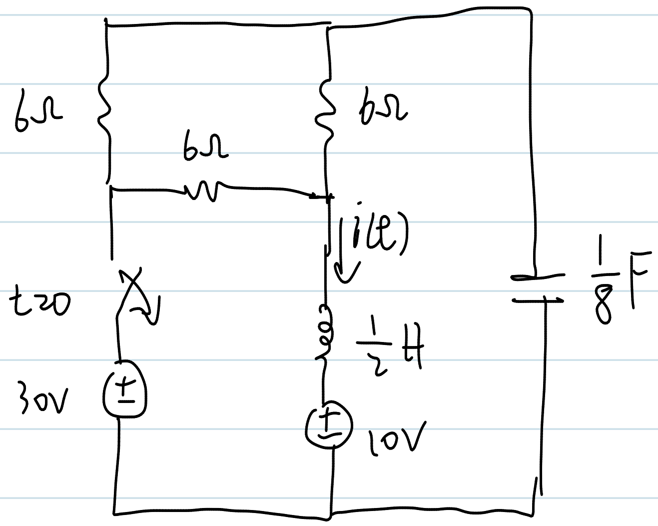
$$i_1(t) = i_1(0)e^{-\frac{t}{\tau_1}}, \quad \tau_1 = \frac{L_1}{R_1} = \frac{2.5}{5} = \frac{1}{2}$$

$$i_1(t) = 2.4e^{-2t}u(t)\ (A)$$ #

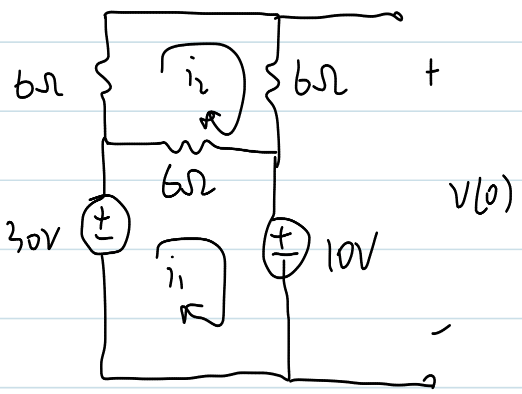
$$i_2(t) = i_2(0)e^{-\frac{t}{\tau_2}}, \quad \tau_2 = \frac{L_2}{R_2} = \frac{4}{20} = \frac{1}{5}$$

$$i_2(t) = 0.6e^{-5t}u(t)\ (A)$$ #

8.



at $t=0^-$



$18i_2 - 6i_1 = 0$, $i_1 = 3i_2 \cdots (1)$

$-30+6(i_1-i_2)+10=0$ $\quad i_1 - i_2 = \frac{10}{3} \cdots (2)$

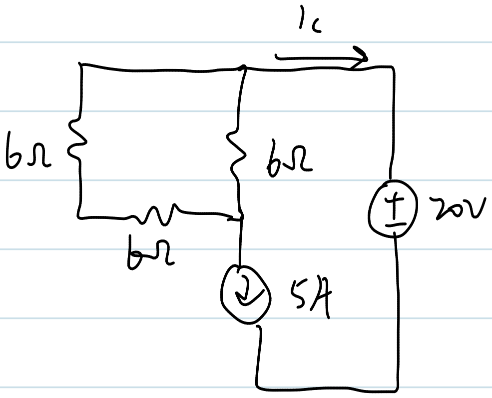
by solving (1),(2)

$i_1=5$, $i_2=\frac{5}{3}$

$i(0)=i_1=5$ (A)

$-10-6i_2+V(0)=0$, $V(0)=10+6\times\frac{5}{3}=20$

at $t>0$



$R=6\,//\,12=4$, $W_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(\frac{1}{2})(\frac{1}{8})}}=4$

$\alpha=\frac{R}{2L}=\frac{4}{2\times(\frac{1}{2})}=4$

$V(t)=V_s+[(A+Bt)e^{-4t}]$, $V_s=10$

$V(0)=20=10+A$, $A=10$

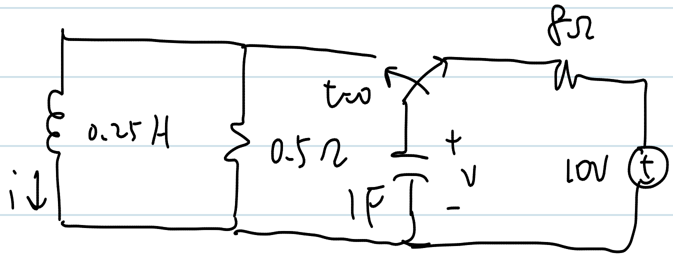
$i_c = C\frac{dV}{dt} = C[-4(10+Bt)e^{-4t}] + C[(B)e^{-4t}]$

$\boxed{i_c(0)=-5} = C(-40+B)$, $-40=-40+B$, $B=0$

$i_c = C\frac{dv}{dt} = \frac{1}{8}[-4(10+0t)e^{-4t}]+(\frac{1}{8})[0e^{-4t}]$

$i_c(t)=[-\frac{1}{2}(10)e^{-4t}]$, $i(t)=-i_c(t)=5e^{-4t}$ (A), $t>0$ #

9.



$t<0$, $i(0)=0$, $V(0^+)=10V$

$$\frac{dV(0)}{dt} = -\frac{[V(0)+Ri(0)]}{RC} = -\frac{(10+0)}{0.5} = -20, V/s$$

$t \geq 0$,

$$\alpha = \frac{1}{2RC} = \frac{1}{2\times 0.5\times 1} = 1, \quad \omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.25\times 1}} = 2$$

$$\omega = \sqrt{\omega_0^2-\alpha^2} = \sqrt{4-1} = 1.732$$

$$V(t) = e^{-t}(A_1\cos 1.732t + A_2\sin 1.732t)$$

$$V(0) = 10V = A_1$$

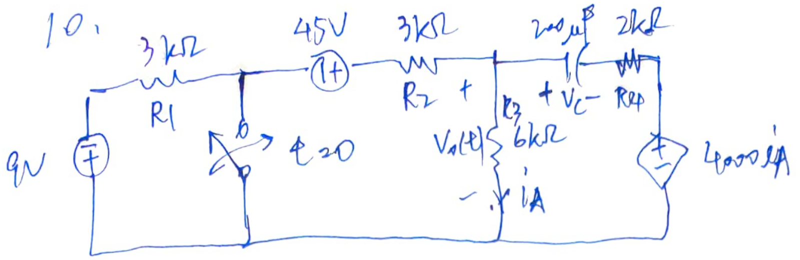
$$\frac{dv}{dt} = -e^{-t}A_1\cos 1.732t - 1.732e^{-t}A_1\sin 1.732t$$
$$-e^{-t}A_2\sin 1.732t + 1.732e^{-t}A_2\cos 1.732t$$

$$\frac{dV(0)}{dt} = -20 = -A_1 + 1.732A_2, \quad A_2 = -5.774$$

$$V(t) = [10\cos(1.732t) - 5.774\sin(1.732t)]e^{-t}\,V, \quad t>0$$

#

10.



$V_o(t) = k_1 + k_2 e^{-t/\tau}$

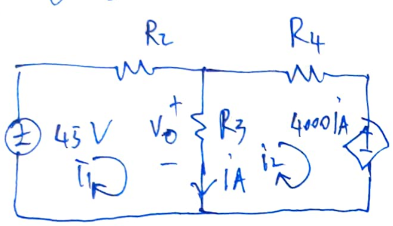
at $t=0^-$, $9 - 45 + i_A R_1 + i_A R_2 + i_A R_3 = 0$, $i_A = 3(mA)$

$V_C(0^-) = V_o(0^-) - 4000\, i_A(0^-)$

$V_o(0^-) = R_3\, i_A(0^-) = 18V$, $V_C(0^-) = 18 - 4000(3mA)$

$= 18 - 12 = 6\, V$,

at $t=0^+$



$45 = i_1(R_2+R_3) - i_2 R_3 = 9k i_1 - 6k i_2$ --- (1)

$i_2 R_4 + (i_2 - i_1)R_3 + 6 + 4000\, i_A = 0$ --- (2)

$i_A = i_1 - i_2$ --- (3)

by (2), (3), $-6 = -2k i_1 + 4k i_2$ --- (4)

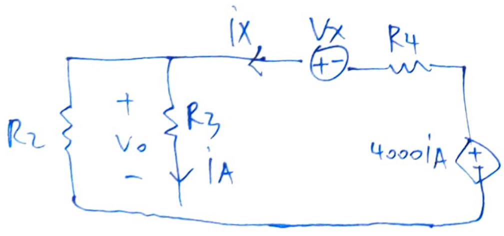
by (1), (4), $i_1 = 6(mA)$, $i_2 = 1.5(mA)$, $i_A(0^+) = 4.5(mA)$

$V_o(0^+) = i_A(0^+) R_3 = 27\ (V) = k_1 + k_2$

at $t = \infty$

$i_A = \dfrac{45}{R_2+R_3} = 5(mA)$, $V_o(\infty) = i_A R_3 = 30(V) = k_1$

$k_2 = -3$



$V_x + 4000\, i_A = i_x(R_2 // R_3 + R_4)$

$\Rightarrow V_x + 4000\, i_A = 4000\, i_x$ --- (5)

$i_A = \dfrac{i_x R_2}{R_2+R_3} = \dfrac{i_x}{3}$ --- (6)

by (5), (6), $R_{eq.} = \dfrac{V_x}{I_x} = 2.67k\Omega$, $\tau = R_{eq} C = 0.534$

$V_o(t) = 30 - 3e^{-1.87t}\ (V)$, $t > 0$

#