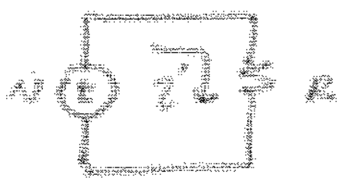
Soln 1.

$P(t) = 20\cos^2 t$ mW , $v = 10\cos t$



$i(t) = \dfrac{P(t)}{v(t)} = \dfrac{(20\cos^2 t)10^{-3}\,W}{10\cos t\ V}$

$i(t) = 2\cos t \times 10^{-3}$ A

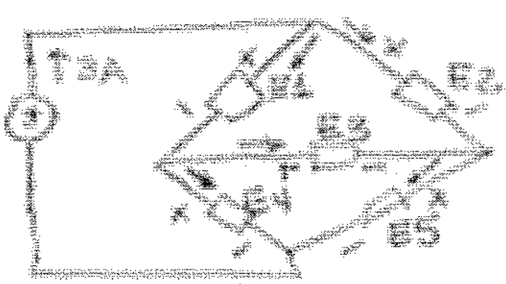
$i(t) = \boxed{2\cos t\ mA}$

by ohm's Law: $v = iR$ $R = \dfrac{v}{i} = \dfrac{10\cos t\ V}{2\cos t \times 10^{-3}\ A}$

$R = 5(10^3)\Omega = \boxed{5\ k\Omega}$

Soln 2.

$V_s = 50$ V



The $V_s = 50$ is supplying Power $= 150$ W

All 5 elements are absorbing power $=$

$= 40 + 40 + (1)V_0 + 30 + 20 = (130 + V_0)$ W

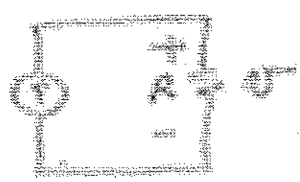
By Conservation of Energy (Power):

$150\,W = (130 + V_0)\,W \rightarrow \boxed{V_0 = 20\ V}$

Soln 4

1 : $v = iR$ $iR > 10$ V

$R > 5\,\Omega$



2 : $P = vi$, $i^2R < 25$ W

$4R < 25$ $R < \frac{25}{4} < 6.25\ \Omega$

3 Design: **5.1** **6.2** **6.3**

HW Set 1 | Soln 5 | SP 2018

Soln 5

Consumption per day: $\left(120W \frac{4h}{day} + 60W \frac{8h}{day}\right)$
$= 960 \frac{Wh}{day} = 0.96 \frac{KWh}{day}$

Energy Consumption per year (365 days):

$(365)\,days\left(.96 \frac{KWh}{day}\right) = 350\ KWh$

Yearly cost: $(350\ KWh)\left(\frac{\$0.12}{KWh}\right) = \boxed{\$42.05}$

Now you can perform energy consumption analysis and cost @ home, include all other appliances and add them.

Soln3.

For 0 < t < 6s, assuming q(0) = 0,

$$q(t) = \int_0^t i dt + q(0) = \int_0^t 3t dt + 0 = 1.5t^2$$

At t=6, $q(6) = 1.5(6)^2 = 54$

For 6 < t < 10s,

$$q(t) = \int_6^t i dt + q(6) = \int_6^t 18 dt + 54 = 18t - 54$$

At t=10, q(10) = 180 – 54 = 126

For 10<t<15s,

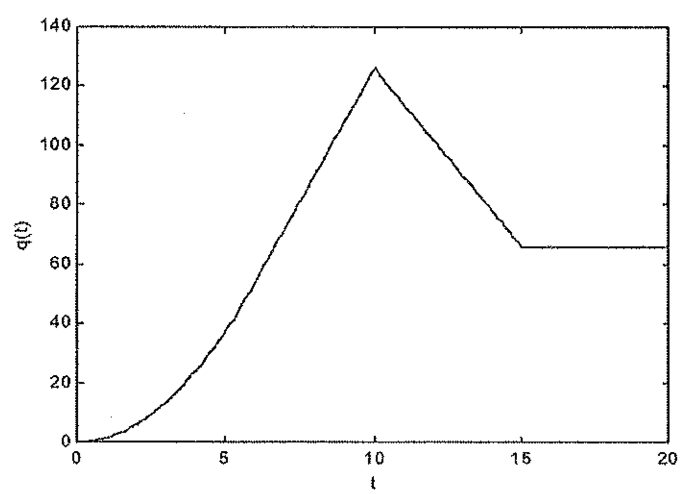
$$q(t) = \int_{10}^t i dt + q(10) = \int_{10}^t (-12) dt + 126 = -12t + 246$$

At t=15, q(15) = -12x15 + 246 = 66

For 15<t<20s,

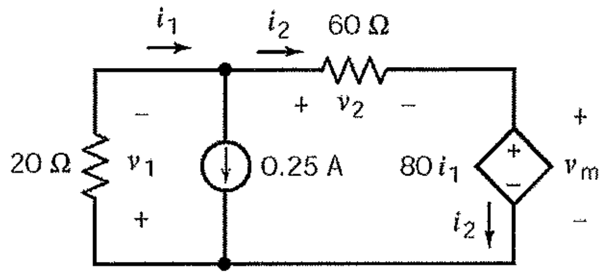
Thus, $q(t) = \int_{15}^t 0 dt + q(15) = 66$

$$q(t) = \begin{cases} 1.5t^2 \text{ C}, & 0 < t < 6\text{s} \\ 18t - 54 \text{ C}, & 6 < t < 10\text{s} \\ -12t + 246 \text{ C}, & 10 < t < 15\text{s} \\ 66 \text{ C}, & 15 < t < 20\text{s} \end{cases}$$



The plot of the charge is shown across.

SOLN1.

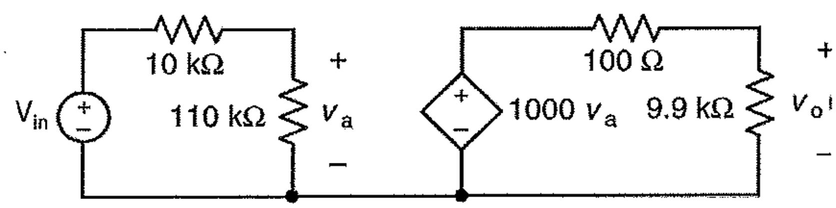


$i_1 = i_2 + 0.25 \qquad v_1 = 20i_1 \qquad v_2 = 60i_2 = 60(i_1 - 0.25) = 60i_1 - 15$

$v_2 + 80i_1 + v_1 = 0 \;\Rightarrow\; (60i_1 - 15) + 80i_1 + 20i_1 = 0 \;\Rightarrow\; i_1 = \dfrac{15}{160} = 0.09375\text{ A}$

$v_m = 80i_1 = 80(0.09375) = 7.5\text{ V}$

SOLN2.



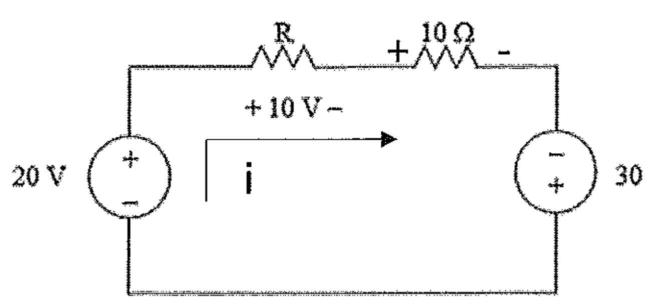
Use Voltage DIV for the first loop to find V_a:

$$V_a = \frac{110k}{(10+110)k}\,10mV = 9.2mV$$

Use Voltage DIV for the second loop to find V_0:

$$V_0 = \frac{9900}{(100+9900)}(1000 \times 9.2mV) = 9.11V$$

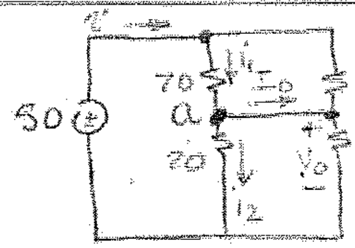
SOLN3.



KVL around the loop:
-20 +10+10i -30 = 0
i = (40V/10Ω) = 4A.
Now: by Ohm's law
10V = iR =(4A) R

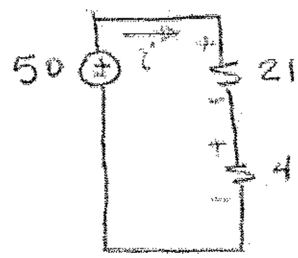
R = (10V/4A) = 2.5Ω

HW and 2 | Soln 4. | SP 2018



$70 \| 30 \quad R_{P_1} = \frac{(30)(70)}{100} = 21\Omega$

$20 \| 5 \quad R_{P_2} = \frac{(5)(20)}{25} = 4\Omega$



$i = \frac{50}{25} = 2A$

$V_{4\Omega} = V_{20\Omega} = V_o = V_{5\Omega} = (2A)(4\Omega) = \boxed{8V}$

$V_{21\Omega} = V_{70\Omega} = V_{30\Omega} = (2A)(21\Omega) = 42V$

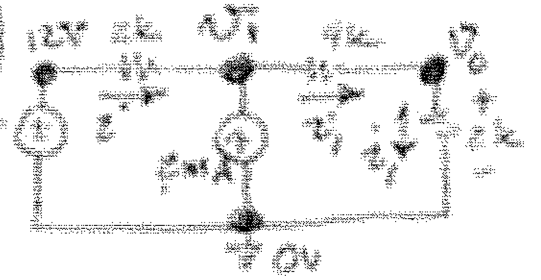
BY Ω'S LAW:

$i_1 = \frac{V_{21\Omega}}{70\Omega} = \frac{42}{70} = 0.6A$

ALSO $i_2 = \frac{8V}{20\Omega} = 0.4A$

HW Set 3 Ch-4 | Soln 1 & 2 | SP 2018

Soln 1.



Nodal analysis @ V_1-node — KCL
$i + 2mA = i_1$

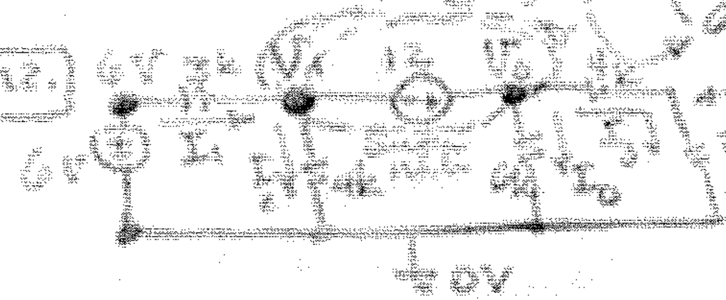
$$\frac{12-V_1}{2k} + 2mA = \frac{V_1 - V_0}{4k} \quad \text{but } \frac{V_1 - V_0}{4k} = \frac{V_0}{2k}$$

$$\text{or} \Rightarrow i_1 = \frac{V_1 - 0}{6k}$$

Either way: $\frac{12-V_1}{2k} + 2mA = \frac{V_1}{6k} \rightarrow V_1 = 12V$

By ohm's law: $V_0 = (2k)i_1 = \left(\frac{V_1}{6k}\right)(2k) = \boxed{4V}$

Soln 2.



4k & 2k are in series = 6k

1st $V_1 - V_0 = -12 \rightarrow V_1 = V_0 - 12$ EQ1

KCL @ super-node: $I_1 = I_2 + I_0 + I_3$

$$\frac{6-V_1}{3k} = \frac{V_1}{4k} + \frac{V_0}{6k} + \frac{V_0}{6k}, \quad \text{EQ2}$$

Sub EQ1 in EQ2:

$$\frac{6 - V_0 + 12}{3k} = \frac{V_0 - 12}{4k} + \frac{2V_0}{6k} \rightarrow \boxed{V_0 = 9.82V}$$

Apply KVL to left mesh: $-3+10\times10^3\, i_1 + 20\times10^3\,(i_1 - i_2) = 0 \Rightarrow \underline{30\times10^3\, i_1 - 20\times10^3\, i_2 = 3}$ (1)

Apply KVL to right mesh: $5\times10^3\, i_1 + 100\times10^3\, i_2 + 20\times10^3\,(i_2 - i_1) = 0 \Rightarrow \underline{\ i_1 = 8 i_2\ }$ (2)

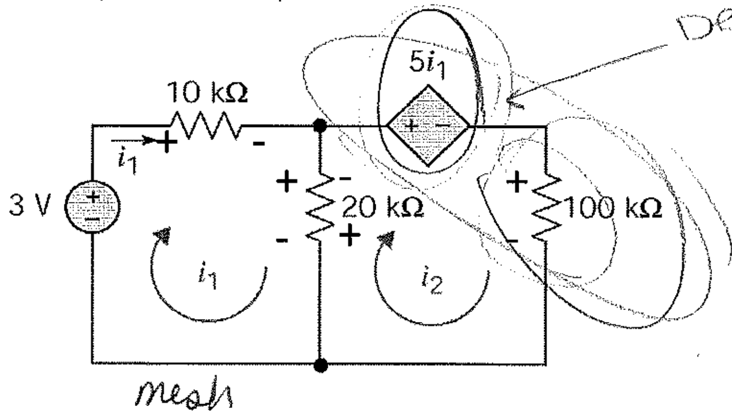
Solving (1) & (2) simultaneously $\Rightarrow$ $i_1 = \dfrac{6}{55}$ mA, $i_2 = \dfrac{3}{220}$ mA

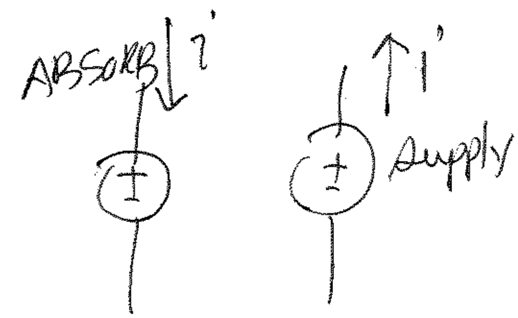
Power delivered to cathode $= (5 i_1)\ (i_2) + 100 (i_2)^2$

$= 5\left(\frac{6}{55}\right)\left(\frac{3}{220}\right) + 100\left(\frac{3}{220}\right)^2 = 0.026$ mW

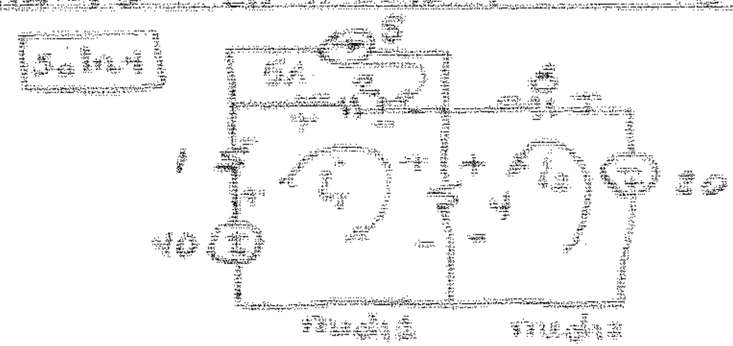
$\therefore$ Energy in 24 hr. $= \left(2.6\times10^{-5}\ \text{W}\right)(24\ \text{hr})\left(3600\ \text{s/hr}\right) = 2.25$ J

Dependent Voltage





HW#3 Ch-4 Soln 4 15Pts



mesh1 : KVL $-40 + i_1 + 2(i_1 - 5) + 4(i_1 + i_2) = 0$

$\Rightarrow 7 i_1 + 4 i_2 = 50$ EQ1

mesh2 : KVL $+20 + 8 i_2 + 4(i_2 + i_1) = 0$

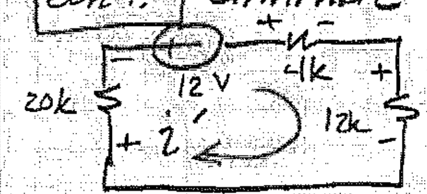
$\Rightarrow 4 i_1 + 12 i_2 = -20$ EQ2

Solve EQ1 & EQ2 simultaneously :

$i_1 = 10A$ $\quad i_2 = -5A$

$V_0 = 4(i_2 + i_1) = 4(10 - 5) = \boxed{20\,V}$

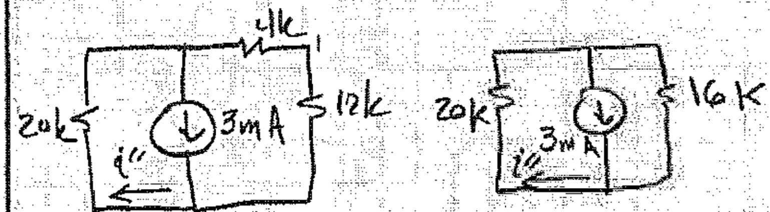
Soln 1. eliminate 3mA, 9mA sources:



KVL: $+20k\,i' + 12 + 4k\,i' + 12k\,i' = 0$

$i' = -\frac{12}{36} = -\frac{1}{3}$ mA

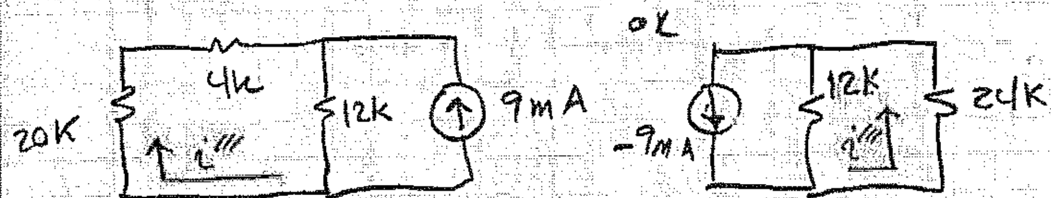
eliminate 9mA & 12V sources:



using C.D.:

$i'' = 3\text{mA}\,\frac{16K}{36K} = \frac{4}{3}$ mA

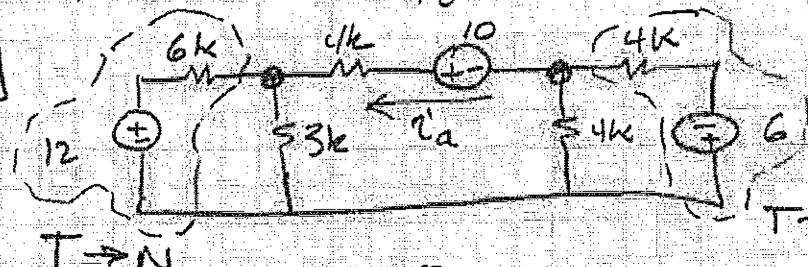
eliminate 3mA & 12V sources:

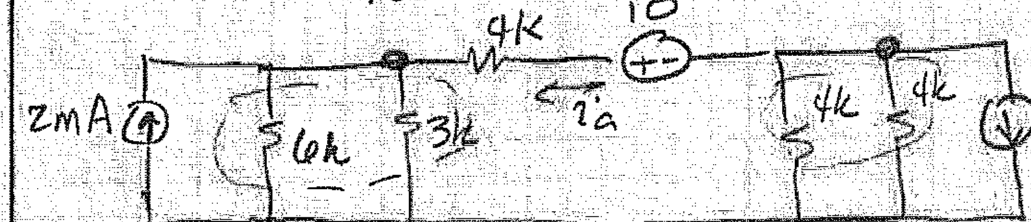


by C.D.: $i''' = (-9\text{mA})\,\frac{12K}{36K} = -3$ mA

$i = i' + i'' + i''' = -1/3\text{ mA} + 4/3\text{ mA} - 3\text{mA} = \boxed{-2\text{mA}}$

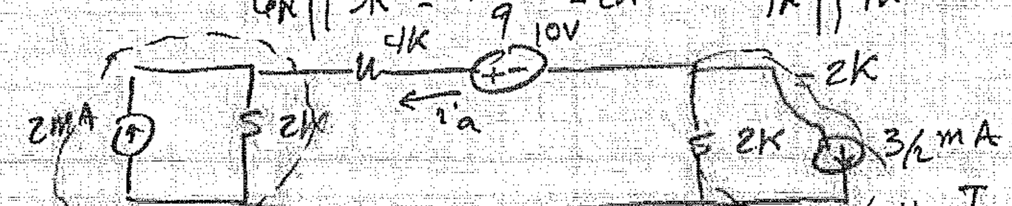
Soln 2.

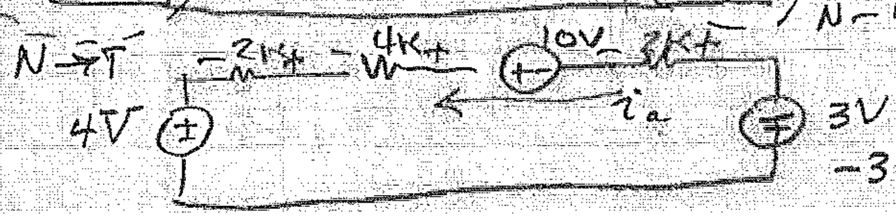




$\frac{6V}{4k} = \frac{3}{2}$ mA

$6k \| 3k = \frac{(6)(3)}{9} = 2K \qquad 4k \| 4k$

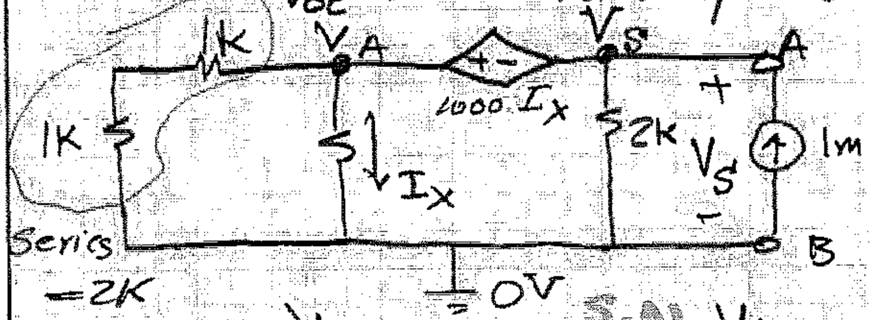




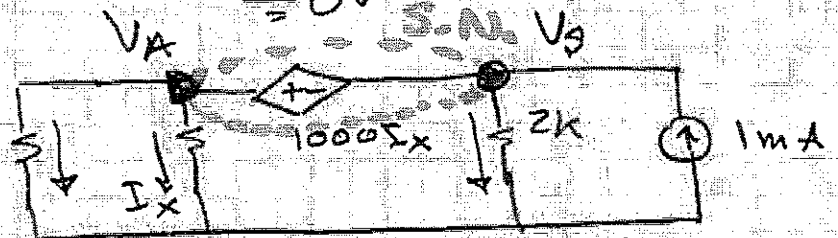
KVL:
$-4 - (2K + 4K + 2K)i_a + 10 - 3 = 0$

$-3 = -8k\,i_a, \quad i_a = \boxed{0.375\text{ mA}}$

Soln 3 The ckt contains only dep sources so its $V_{oc} = 0\,V$ and only has $R_T =$



$$R_T = \frac{V_S}{1\,mA}$$



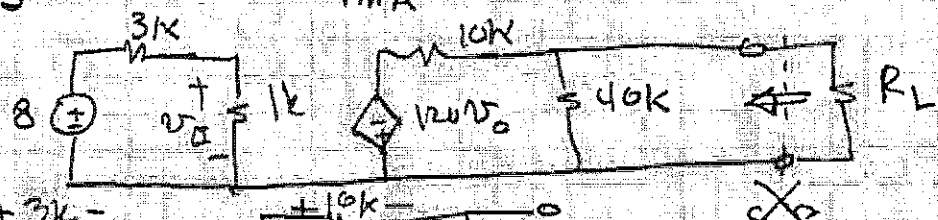
KCL @ supernode $\dfrac{V_A}{2K} + \dfrac{V_A}{2K} + \dfrac{V_S}{2K} = 1\,mA$ EQ 1

ALSO: $\dfrac{V_A}{I_X} = 2K$ $V_A = 2k I_X$ ALSO $V_A - V_S = 1000 I_x$

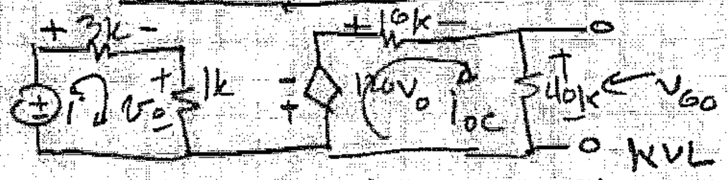
simplify: to get $V_A = 2V_S \Rightarrow$ EQ 1 $\dfrac{2V_S}{2K} = 1\,mA$

$V_S = \dfrac{2}{5}$ so $R_T = \dfrac{2/5}{1\,mA} = 0.4 \times 10^3 = \boxed{400\,\Omega}$

Soln 4



V_{oc}:



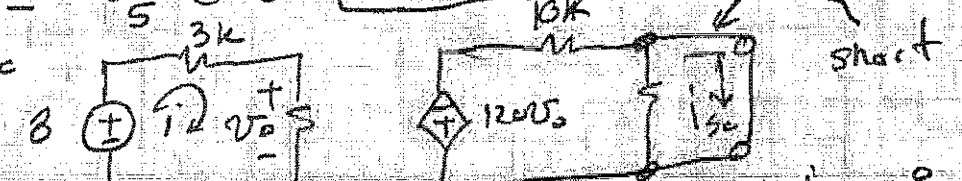
KVL

$-8 + 3ki + ik = 0$, $i = 2\,mA$; $+120 v_o + 10k\, i_{oc} + 40k\, i_{oc} = 0$

$v_o = 2V$ $\quad$ $v_o = 2V$ then $i_{oc} = -\dfrac{24}{5}\,mA$

$V_{oc} = -\dfrac{24}{5}(40) = \boxed{-192\,V}$

Find i_{sc}

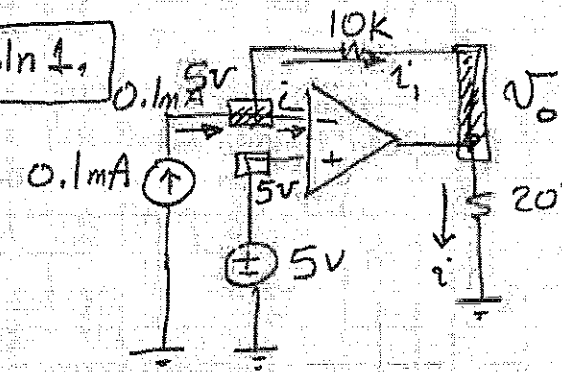


$v_o = 2V$ $\quad$ $+240 + 10k\, i_{sc} = 0$

$R_T = \dfrac{V_{oc}}{i_{sc}} = \dfrac{-192}{-24m} = \boxed{8\,k\Omega}$ $\quad$ $i_{sc} = \boxed{-24\,mA}$

$i_N = \dfrac{-192}{16k} = -12\,mA$ $\quad$ $P_{8k} = (-12\,mA)^2\, 8k = \boxed{1.152\,W}$

Soln 1.



$i_- = 0$ because of principal of open

$v_+ = v_- = 5V$ " " " of short

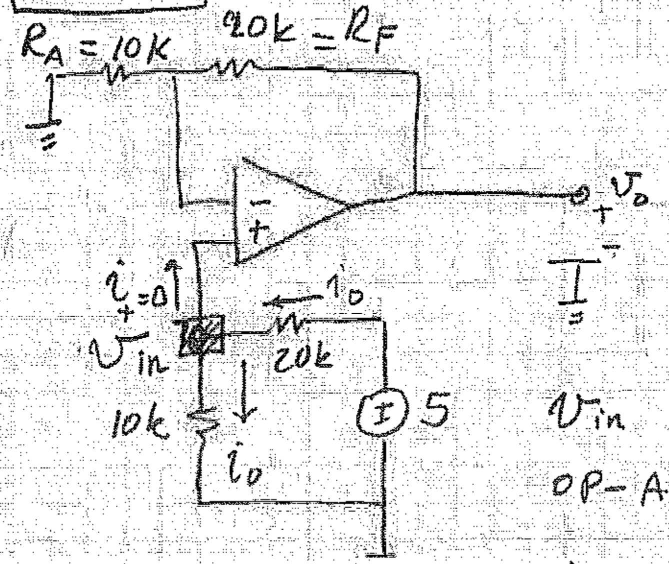
KCL @ (−) input node of Amp: $0.1m = \cancel{i_-}^{\,0} + i_1$

$0.1mA = \dfrac{5 - v_o}{10k} \rightarrow v_o = 4$ so $i = \dfrac{v_o - 0}{20K}$

$i = \dfrac{4\ V}{20k\,\Omega} = 2 \times 10^{-4} = \boxed{0.2mA}$

know voltage @ (−) input is 5 V so the voltage across the 0.1mA source is $\boxed{5V}$.

Soln 2.



$i_o = \dfrac{5\ V}{(20k + 10k)\,\Omega} = \boxed{0.1667\ mA}$

v_{in} is found by V.D.:

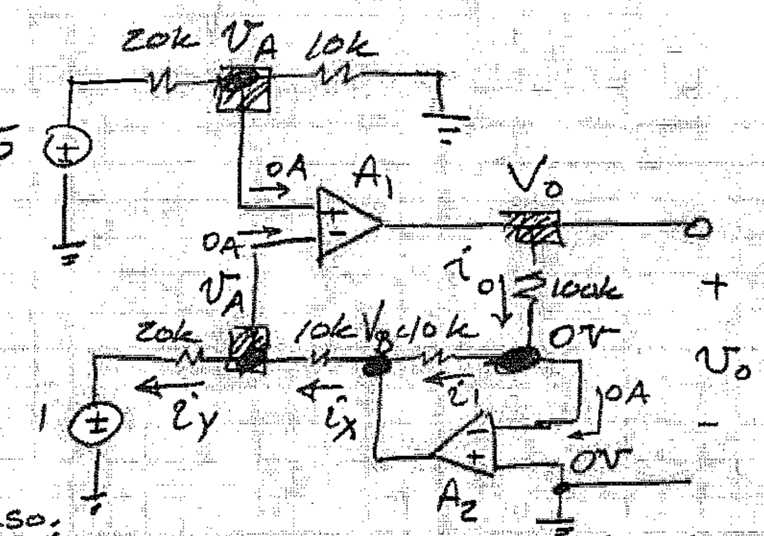
$v_{in} = 5\,\dfrac{10k}{10k + 20k} = \dfrac{5}{3}\ V$

v_{in} is input to the non-inv OP-Amp with Equation =

$v_o = \left(1 + \dfrac{R_F}{R_A}\right) v_{in} = \left(1 + \dfrac{20}{10}\right)\dfrac{5}{3}$

$\boxed{v_o = 5\ V}$

$\boxed{\text{Soln 3}}$



by V.D.:

$v_A = 5\,\frac{10k}{30k} = \frac{5}{3}V$

write KCL @ (−) input of A_2:

$i_o' = i_1$

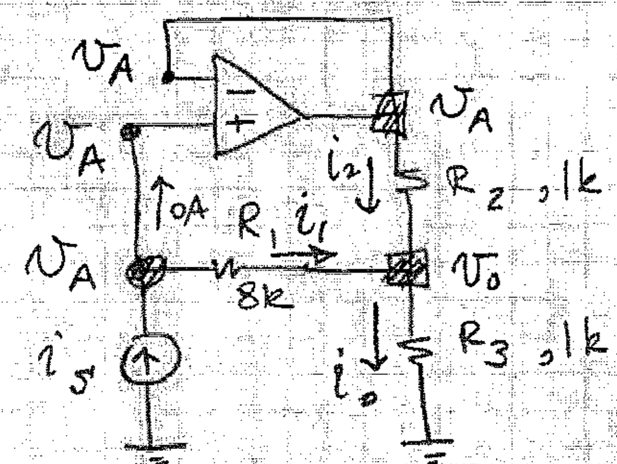
$\frac{v_o - 0}{100k} = \frac{0 - V_B}{40k}$

ALSO: KCL @ v_A (−) input of A_1: $i_X = i_Y$

$\frac{V_B - V_A}{10k} = \frac{V_A - 1}{20k}, \quad \frac{V_B - 5/3}{10k} = \frac{5/3 - 1}{20k} \Rightarrow V_B = 2V$

so $\frac{v_o - 0}{100k} = \frac{0 - 2}{40k} \Rightarrow \boxed{v_o = -5V}$

$\boxed{\text{Soln 4.}}$



by Inspection (KCL):

$i_S = i_1$

KCL @ v_o node:

$i_2 + i_1 = i_o$

$i_2 + i_S = i_o$

$i_S = i_o - i_2$

notice:

$v_{R_2} = v_{R_1} \quad i_S\, 8\cancel{k} = i_2\, 1\cancel{k} \quad i_2 = 8\, i_S$

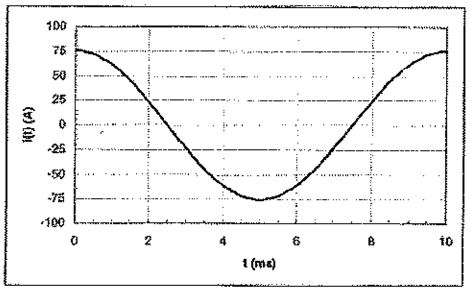
$i_S = i_o - 8\, i_S \Rightarrow 9\, i_S = i_o \Rightarrow$

$\frac{i_o}{i_S} = \boxed{9}$

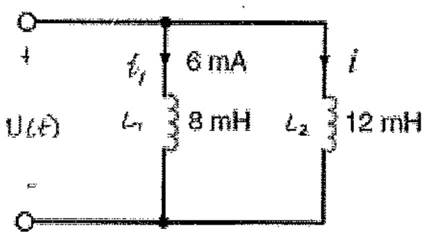
Solution 1.

$i = C\,dv/dt \qquad v = 12 \sin \omega t \qquad \omega = \frac{2\pi}{T} \qquad T = 10\,ms \Rightarrow \omega = 200\pi$ r/s

$$\boxed{i = 75.4 \cos \omega t \text{ mA} \qquad \omega = 200\pi \text{ r/s}}$$



Solution 2.



$$\left.\begin{array}{ll} \text{for } L_1 & i_1 = \frac{1}{L_1}\int v(t)\,dt \\ \text{for } L_2 & i = \frac{1}{L_2}\int v(t)\,dt \end{array}\right\} \quad \frac{i}{i_1} = \frac{L_1}{L_2}$$

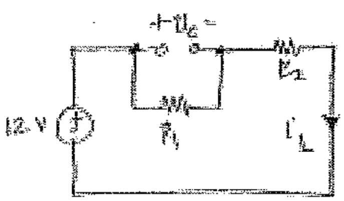
$$i = i_1 \left(L_1/L_2\right) \qquad \boxed{i = 4\,mA}$$

Solution 3.

Since voltage source is constant, v_c and i_L are constant

$i_c = C\,dv_c/dt = 0$ & $v_L = L\,di_L/dt = 0$

<u>New circuit</u>



$$i_L = \frac{12}{R_1 + R_2} = 40\,mA$$

$$v_c = \frac{12\,R_1}{R_1 + R_2} = 8V$$

$$w_c = \frac{1}{2} C v_c^2 = w_L = \frac{1}{2} L i_L^2 \Rightarrow C = L\left(\frac{i_L}{v_c}\right)^2$$

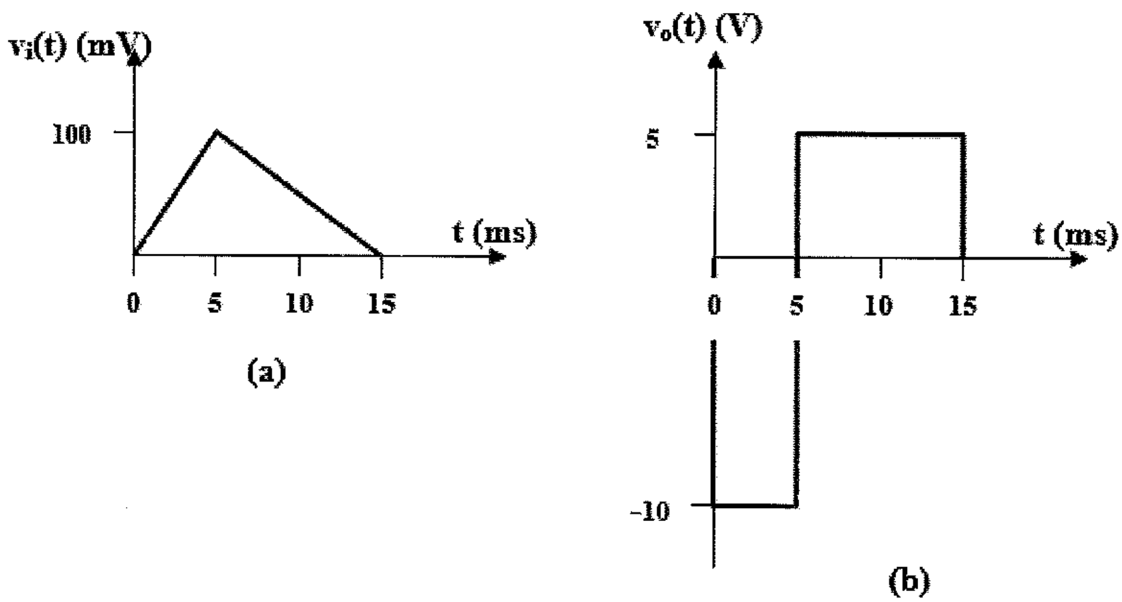
$$\boxed{C = 2.5\,\mu F}$$

Solution 4.

$$v_o = -RC\frac{dv_i}{dt},\ RC = 50 \times 10^3 \times 10 \times 10^{-6} = 0.5$$

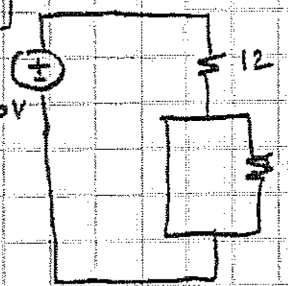
$$v_o = -0.5\frac{dv_i}{dt} = \begin{cases} -10, & 0 < t < 5 \\ 5, & 5 < t < 15 \end{cases}$$

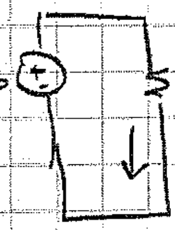
The input is sketched in Fig. (a), while the output is sketched in Fig. (b).



Soln 1.

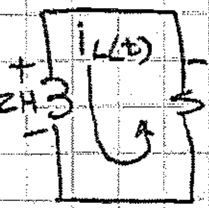
For $t=0^-$,





$i_L(0^-) = \frac{6}{12} = 0.5A$

For $t=0^+$ or $t>0$:



KVL:

$2\frac{di}{dt} + 6i = 0 \Rightarrow$

$\frac{di_L}{dt} + 3i_L = 0$, $i_L = Ke^{st}$

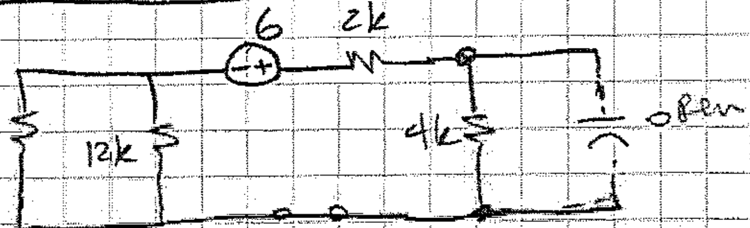
$Kse^{st} + 3Ke^{st} = 0$, $S = -3$, $i_L(t) = Ke^{-3t}$ $i_L(0) = 0.5A$

$$\boxed{i_L(t) = 0.5e^{-3t}\ A}$$

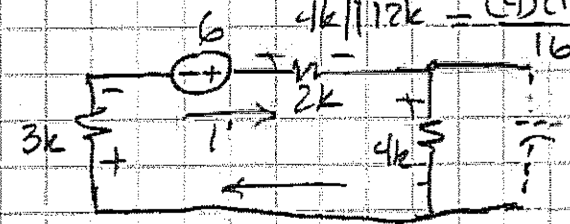
Soln 2.

$V_c(0^-) = V_{R4}$

For $t=0^-$



$4k \| 12k = \frac{(4)(12)}{16} = 3k$

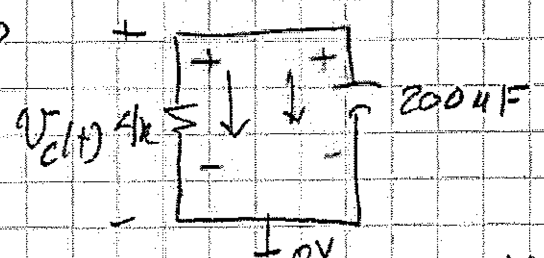


$+3ki - 6 + 2ki + 4ki = 0$, $i = \frac{6}{9}mA$

$i(0^-) = \frac{2}{3}mA$ $V_{R4} = \frac{8}{3}V$

So $V_c(0^-) = V_c(0) = \frac{8}{3}V$

For $t>0$



$I_{4k} + I_c = 0$

$\frac{V_c - 0}{4k} + 200\frac{dV_c}{dt} = 0$

$V_c + 200 \cdot 10^{-6} \cdot 4 \cdot 10^3 \frac{dV_c}{dt} = 0$

$V_c + 0.8\frac{dV_c}{dt} = 0$

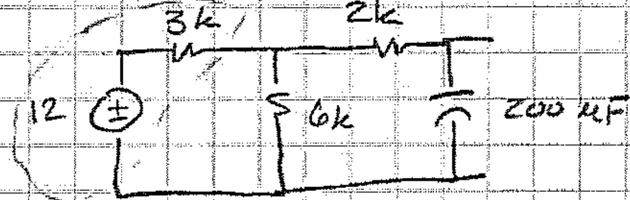
$\frac{dV_c}{dt} + 1.25V_c = 0 \rightarrow V_c(t) = Ke^{-1.25t}$

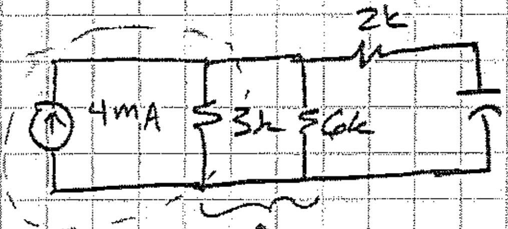
$V_c(0) = \frac{8}{3} \Rightarrow$ $V_c(0) = 8/3 = Ke^0 \Rightarrow K = \frac{8}{3} = 2.67$

$$\boxed{V_c(t) = 2.67e^{-1.25t}}$$

Soln 3. For $t=0^-$ or $t<0$ $v(t)=0$, then $\boxed{V_c(0)=V_0=0}$

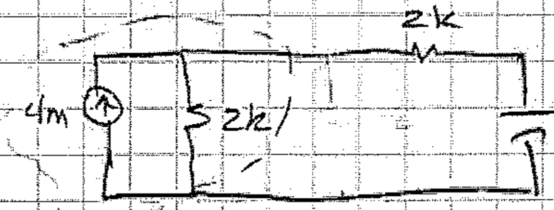
For $0\le t\le 1$ $v(t)=12V$

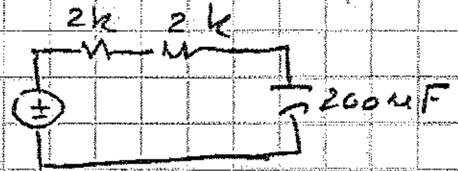




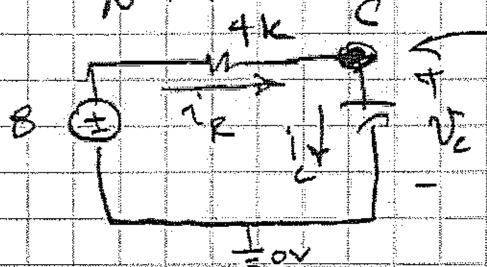
T → N

$3k \| 6k = \frac{(3)(6)}{9} = 2k$





N → T



KCL @ c-node:

@: $i_R = i_c$ $\quad \frac{8-V_c}{4k} = 200\mu \frac{dv_c}{dt}$

$8 - V_c = 4\cdot 10^3 \cdot 200\cdot 10^{-6} \frac{dv_c}{dt}$

$8 - V_c = 0.8 \frac{dv_c}{dt}$

$\frac{dv_c}{dt} + \frac{V_c}{0.8} = \frac{8}{0.8} = 10$ $\quad \frac{dv_c}{dt} + 1.25\, V_c = 10$,

try $V_{cf} = K_1 \rightarrow$ Sub $\quad 0 + 1.25 K_1 = 10$, $K_1 = 8$

$\frac{dv_c}{dt} + 1.25 V_c = 0 \Rightarrow V_{cn} = K_2 e^{-1.25t} \Rightarrow$

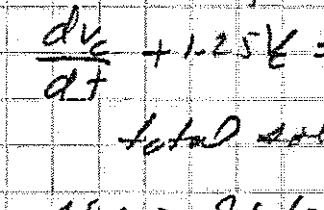
total soln $V_c(t) = K_1 + K_2 e^{-1.25t} = 8 + K_2 e^{-1.25t}$

$V_c(0) = V_0(0) = 0 = 8 + K_2 e^0 \longrightarrow K_2 = -8$

$\boxed{V_c(t) = 8 - 8e^{-1.25t} \quad \text{for } 0 \le t \le 1}$

For $t>1 \rightarrow$ the 12-V source goes to zero:

ALSO $t = 1^- \Rightarrow V(1) = 8 - 8e^{-1.25}$



no source in the ckt $\quad V(1) = 8 - 8(0.29) = 5.71V$

so: the new soln:

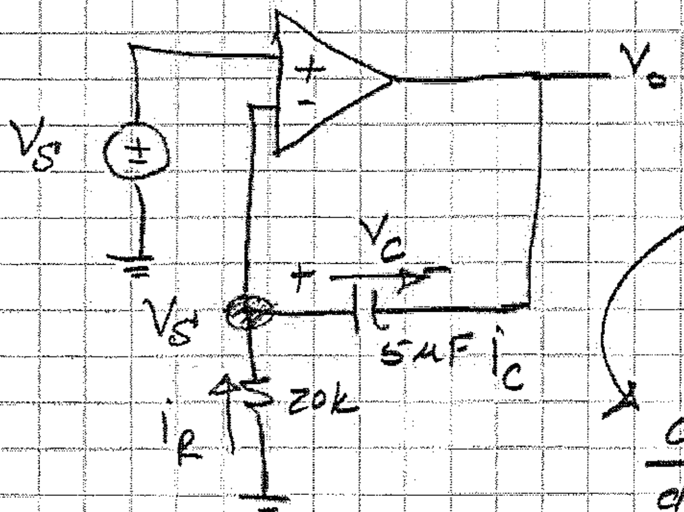
$V_c(t) = K_3 e^{-1.25t}$ $\quad V(1) = 5.71 = K_3 e^{-1.25(1)}$

$K_3 = 5.71 e^{1.25}$

$\boxed{V_c(t) = 5.71 e^{-1.25(t-1)} \quad \text{for } t>1}$

For $t < 0$ switch is open $v_c(0) = 0$, $V_s = 0$
so $v_o(0) = 0$

For $t > 0$ KCL @ (−) input of OP-Amp



$$i_R = i_C$$

$$\frac{0 - V_s}{20k} = C\,\frac{dV_c}{dt}$$

ALSO : $V_S - V_o = V_c$

$$\frac{dV_c}{dt} = -\frac{V_s}{RC} \quad , \; dV_c = -\frac{V_s}{RC}\int dt + V_c(0)$$

$$dV_c = -\frac{V_s}{RC}\int dt + \cancelto{0}{V_c(0)}$$

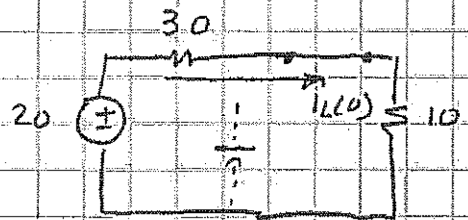
$$RC = 20 \cdot 10^{3} \cdot 5 \cdot 10^{-6} = 0.1\,s$$

$$V_c = -\frac{V_s}{RC}\,t = -\frac{20}{0.1}\,t \text{ mV} \quad \text{since } V_s = 20\text{mV}$$

$$V_o = V_s - V_c = 20\text{mV} - \left(-\frac{20t}{0.1}\right)\text{mV} = \boxed{20(1 + 10t)\text{ mV}}$$

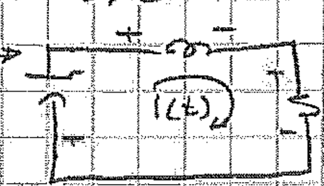
Soln 1. This is RLC series ckt.

for $t=0^-$ or $t<0$:



$v_c(0)=0$, $i_L(0)=\frac{20V}{40}=0.5A$

For $t>0$



$$+4\frac{di}{dt}+10i+\frac{1}{0.25}\int i\,dt+v(0)=0$$

$$4\frac{d^2i}{dt^2}+10\frac{di}{dt}+4i=0 \longrightarrow \frac{d^2i}{dt^2}+2.5\frac{di}{dt}+i=0$$

$$s^2+2.5s+1=0 \qquad s=\frac{-2.5\pm\sqrt{6.25-4}}{2} \quad \frac{-2.5+1.5}{2}=-0.5, \quad \frac{-2.5-1.5}{2}=-2$$

$$i(t)=K_1e^{-2t}+K_2e^{-.5t}$$

$$v(t)=\int(K_1e^{-2t}+K_2e^{-.5t}) \Rightarrow \frac{K_1}{-2}e^{-2t}+\frac{K_2}{-.5}e^{-.5t}$$

$$\Rightarrow v(t)=Ae^{-2t}+Be^{-.5t} \qquad v(0)=0=A+B=0,\ \boxed{A=-B} \text{ EQ1}$$

$$i_c\Big|_{t=0}=i_L(t)\Big|_{t=0}=0.5\Big|_{t=0}=C\frac{dv}{dt}\Big|_{t=0}=0.25(-2Ae^{-2t}-0.5Be^{-0.5t})=0.5$$

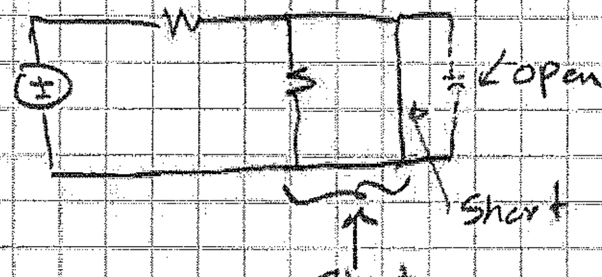
$$4\times0.25(-2Ae^{-2t}-0.5\cdot Be^{-0.5t})=0.5\times4 \quad \text{at } t=0$$

$$\boxed{-2A-0.5B=2} \text{ EQ2} \quad \text{Solving EQ1 \& EQ2: } A=-1.33 \text{ and } B=1.33$$

$$\boxed{v(t)=-1.33e^{-2t}+1.33e^{-0.5t}}$$

$\boxed{\text{Soln 2.}}$ this is RLC parallel ckt:

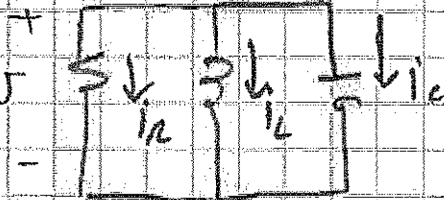
For $t<0$



$V_c(0)=0$

$i(0) = 20/5 = 4A$ So I.C: $v_c(0)=0$, $i(0)=0$

For $t>0$



$i_R + i_L + i_c = 0$

$\frac{v}{R} + \frac{1}{L}\int v\,dt + i_L(0) + C\frac{dv}{dt} = 0$ EQ 1

$\frac{d}{dt}$ of EQ 1:

$$C\frac{d^2v}{dt^2} + \frac{1}{R}\frac{dv}{dt} + \frac{v}{L} = 0 \quad C = 1F,\ R = 1\Omega,\ L = 0.25H$$

$$\Rightarrow S^2 + S + 4 = 0$$

$$S_1, S_2 = \frac{-1 \pm \sqrt{1-16}}{2} \quad \begin{cases} \frac{-1+\sqrt{-15}}{2} = \\ \frac{-1-\sqrt{-15}}{2} = \end{cases}$$

$S_1 = -0.5 + j1.94$

$S_2 = -0.5 - j1.94$

$v(t) = e^{-0.5t}(K_1 \cos 1.94t + K_2 \sin 1.94t)$

$v(0) = 0 = K_1(\cos 0) + K_2 \sin(0) \Rightarrow K_1 = 0$

$$i_c\Big|_{t=0} = -i_R\Big|_{t=0} - i_L\Big|_{t=0} = -\frac{\overset{\to 0}{v_{1\Omega}(0)}}{1} - 4$$

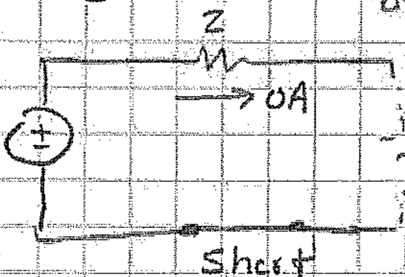
$$C\frac{dv}{dt}\Big|_{t=0} \Rightarrow C = 1F,\ \frac{dv}{dt}\Big|_{t=0} = -4$$

$$\frac{dv}{dt} = e^{-.5t}(0.5)(K_1 \cos 1.94t + K_2 \sin 1.94t) + e^{-.5t}(-1.94K_1 \sin 1.94t + 1.94K_2 \cos 1.94t)$$

$$\frac{dv}{dt}\Big|_{t=0} = -0.5K_1 + 1.94K_2 \Rightarrow -0.5K_1 + 1.94K_2 = -4$$

$K_2 = -2.1$ $\boxed{v(t) = -2.1e^{-0.5t}\sin 1.94t}$

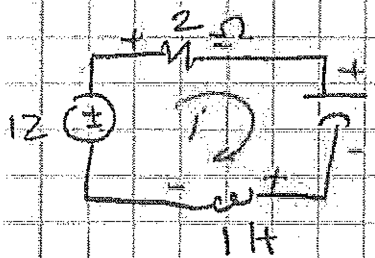
$\boxed{\text{Soln 3}}$ for $t<0$ I.C. =



C is open

$V_{2\Omega} = 0$, so $V_c(0) = 8\,V$

and $i_L(0) = 0$ for $t>0$



$-12 + 2i + v_c + v_c(0) + \dfrac{di}{dt} = 0$

notice $i = C\dfrac{dv_c}{dt} \rightarrow \dfrac{di}{dt} = C\dfrac{d^2v_c}{dt^2}$

$-12 + 2C\dfrac{dv_c}{dt} + v_c + C\dfrac{d^2v_c}{dt} = 0$

$-12 + \dfrac{2}{5}\dfrac{dv_c}{dt} + v_c + \dfrac{1}{5}\dfrac{d^2v_c}{dt^2} = 0$

$\dfrac{d^2v_c}{dt^2} + 2\dfrac{dv_c}{dt} + 5v_c = 60 \longrightarrow V_c(t) = V_{cn} + V_{cf}$

$V_f = A$, $0 + 0 + 5A = 60$ $\boxed{A=12}$ so $v_{cf} = 12$

$s^2 + 2s + 5 = 0 \longrightarrow s_1 = -1 + j2 \quad s_2 = -1 - j2$

$v_{cn} = e^{-t}(K_1 \cos 2t + K_2 \sin 2t)$

$v_c(t) = e^{-t}(K_1 \cos 2t + K_2 \sin 2t) + 12$

$v_c(0) = 8 = e^0(K_1 + 0) + 12 \quad 8 = K_1 + 12$, $K_1 = -4$

from I.C.

$\rightarrow i_c(0) = i_L(0) = 0 \quad i(0) = C\dfrac{dv_c(0)}{dt} = 0$

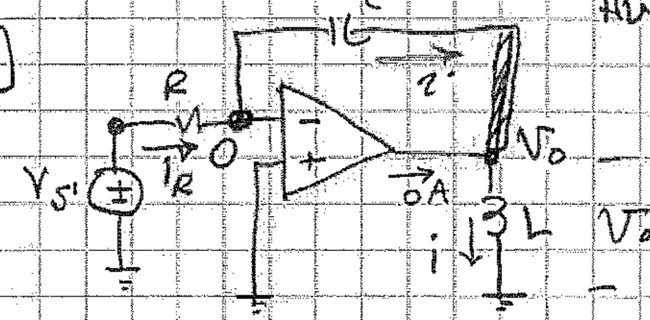
$\dfrac{dv_c(0)}{dt} = 0 \quad \dfrac{dv_c}{dt} = -(K_1 \cos 2t + K_2 \sin 2t)e^{-t}$

$+ e^{-t}(-K_1 2\sin 2t + 2K_2 \cos 2t)$, $\dfrac{dv_c(0)}{dt} = -K_1 + 2K_2 = 0$

$-(-4) + 2K_2 = 0$, $K_2 = -2$

$$\boxed{v_c(t) = -e^{-t}(4\cos 2t + 2\sin 2t) + 12}$$

Soln 4.



KCL @ (−) input of Amp : $i_R = i$

$$\frac{V_S - 0}{R} = C\frac{d(0 - V_o)}{dt} \Rightarrow \frac{V_S}{R} = -C\frac{dV_o}{dt}$$

V_o is across the the inductor L,

$$V_o = L\frac{di}{dt} \Rightarrow$$

$$\frac{V_S}{R} = -C\frac{d}{dt}\left[\frac{di}{dt}\right]L = -C\frac{d^2 i}{dt^2}L$$

$$\boxed{\frac{d^2 i}{dt^2} = -\frac{V_S}{RCL}}$$

Solution 1.

(a) $4\sin(\omega t - 30°) = 4\cos(\omega t - 30° - 90°) = \underline{\mathbf{4\cos(\omega t - 120°)}}$

(b) $-2\sin(6t) = \underline{\mathbf{2\cos(6t + 90°)}}$

(c) $-10\sin(\omega t + 20°) = 10\cos(\omega t + 20° + 90°) = \underline{\mathbf{10\cos(\omega t + 110°)}}$

Solution2.

(a) $v(t) = 10\cos(4t - 60°)$
$i(t) = 4\sin(4t + 50°) = 4\cos(4t + 50° - 90°) = 4\cos(4t - 40°)$

Thus, **i(t) leads v(t) by 20°**.

(b) $v_1(t) = 4\cos(377t + 10°)$
$v_2(t) = -20\cos(377t) = 20\cos(377t + 180°)$

Thus, **$v_2(t)$ leads $v_1(t)$ by 170°**.

(c) $x(t) = 13\cos(2t) + 5\sin(2t) = 13\cos(2t) + 5\cos(2t - 90°)$
$\mathbf{X} = 13\angle 0° + 5\angle -90° = 13 - j5 = 13.928\angle -21.04°$

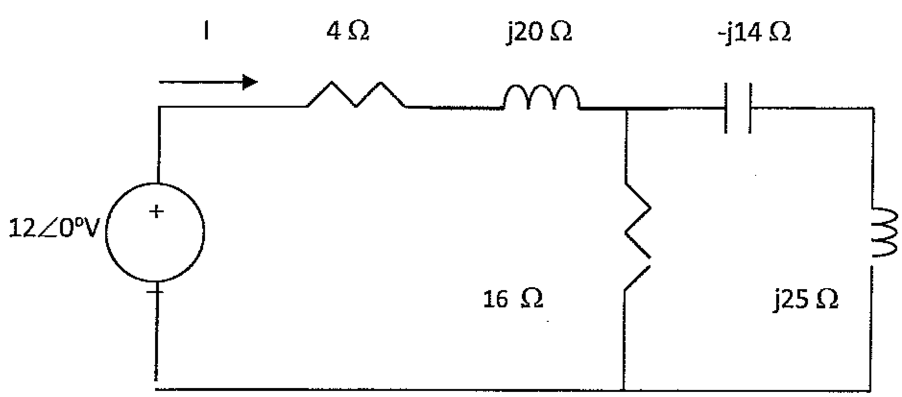
$x(t) = 13.928\cos(2t - 21.04°)$

$y(t) = 15\cos(2t - 11.8°)$

phase difference $= -11.8° + 21.04° = 9.24°$

Thus, **y(t) leads x(t) by 9.24°**.

Solurtion3.



Solution 3 continued

$$Z_{eq} = 4 + j20 + 10//(-j14 + j25) = \underline{9.135 + j27.47\ \ \Omega}$$

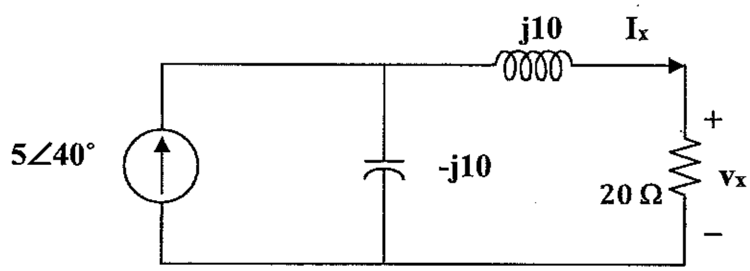
$$I = \frac{V}{Z_{eq}} = \frac{12}{9.135 + j27.47} = 0.4145 < -71.605^o$$

$$i(t) = \underline{0.4145\cos(10t - 71.605^o)\ \ A} = \underline{\mathbf{414.5cos(10t–71.6^\circ)\ mA}}$$

Solution4.

Since ω = 100, the inductor = j100x0.1 = j10 Ω and the capacitor = 1/(j100x10^{-3})

= -j10Ω.

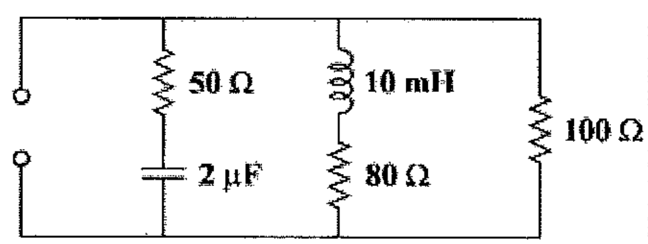


Using the current dividing rule:

$$I_X = \frac{-j10}{-j10 + 20 + j10} 5\angle 40° = -j2.5\angle 40° = 2.5\angle -50°$$
$$V_X = 20 I_X = 50\angle -50°$$
$$v_X = \underline{50\cos(100t - 50°)\,V}$$

Solution5.

ω = 2πf = 2(3.14)2000=12560



$$Z_1 = 50 + \frac{1}{j\omega C} = 50 + \frac{-j}{(2\pi)(2\times 10^3)(2\times 10^{-6})}$$

Solution 5 continued

$$\mathbf{Z}_1 = 50 - j39.79$$

$$\mathbf{Z}_2 = 80 + j\omega L = 80 + j(2\pi)(2\times10^3)(10\times10^{-3})$$

$$\mathbf{Z}_2 = 80 + j125.66$$

$$\mathbf{Z}_3 = 100$$

$$\frac{1}{\mathbf{Z}} = \frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \frac{1}{\mathbf{Z}_3}$$

$$\frac{1}{\mathbf{Z}} = \frac{1}{100} + \frac{1}{50 - j39.79} + \frac{1}{80 + j125.66}$$

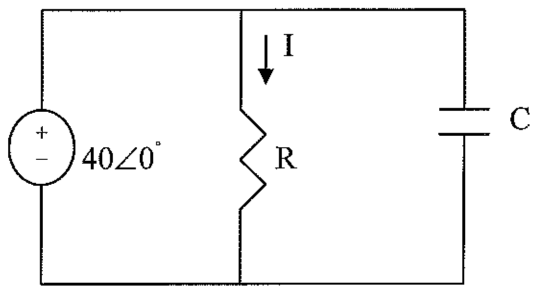
$$\frac{1}{\mathbf{Z}} = 10^{-3}\,(10 + 12.24 + j9.745 + 3.605 - j5.663)$$

$$= (25.85 + j4.082)\times10^{-3}$$

$$= 26.17\times10^{-3}\angle 8.97°$$

Z = <u>38.21∠-8.97° Ω</u>

Solution1.



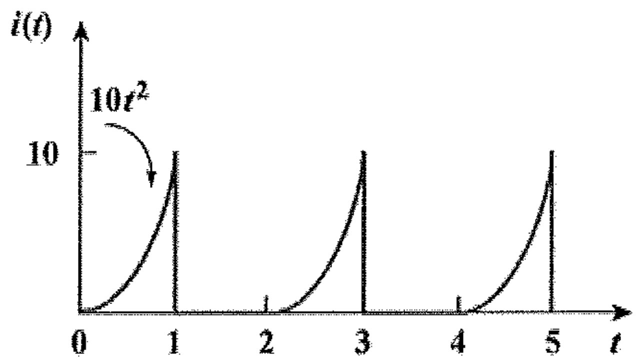
$$90\ \mu\text{F} \quad \longrightarrow \quad \frac{1}{j\omega C} = \frac{1}{j90x10^{-6}x2x10^{3}} = -j5.5556$$

I = 40/60 = 0.6667A or I_{rms} = 0.6667/1.4142 = 0.4714A

The average power delivered to the load is the same as the average power absorbed by the resistor which is

P_{avg} = $|I_{rms}|^2$60 = **<u>13.333 W</u>**.

Solution2.

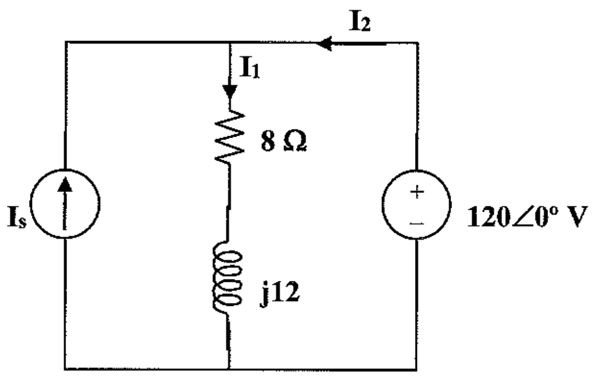


$$I_{rms}^2 = \frac{1}{2}\left[\int_0^1 (10t^2)^2\ dt + \int_1^2 0\ dt\right]$$

$$I_{rms}^2 = 50\int_0^1 t^4\ dt = 50\cdot\frac{t^5}{5}\Big|_0^1 = 10$$

$$I_{rms} = \underline{\mathbf{3.162\ A}}$$

Solution3.



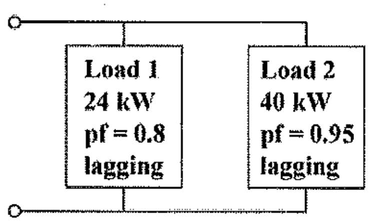
$I_s + I_2 = I_1$ or $I_s = I_1 - I_2$

$$I_1 = \frac{120}{8+j12} = 4.615 - j6.923$$

But, $$S = VI_2^* \longrightarrow I_2^* = \frac{S}{V} = \frac{2500 - j400}{120} = 20.83 - j3.333$$

$$\text{or } I_2 = 20.83 + j3.333$$

Solution4.



(a) $$\theta_1 = \cos^{-1}(0.8) = 36.87°$$

$$S_1 = \frac{P_1}{\cos\theta_1} = \frac{24}{0.8} = 30 \text{ kVA} \quad Q_1 = S_1 \sin\theta_1 = (30)(0.6) = 18 \text{ kVAR}$$

$$\mathbf{S}_1 = 24 + j18 \text{ kVA} \qquad \theta_2 = \cos^{-1}(0.95) = 18.19°$$

$$S_2 = \frac{P_2}{\cos\theta_2} = \frac{40}{0.95} = 42.105 \text{ kVA} \qquad Q_2 = S_2 \sin\theta_2 = 13.144 \text{ kVAR}$$

$\mathbf{S}_2 = 40 + j13.144\ \text{kVA} \qquad \mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 = 64 + j31.144\ \text{kVA}$

$\theta = \tan^{-1}\left(\dfrac{31.144}{64}\right) = 25.95° \qquad \text{pf} = \cos\theta = \underline{\mathbf{0.8992}}$

(b) $\theta_2 = 25.95°, \qquad \theta_1 = 0°$

$$Q_c = P[\tan\theta_2 - \tan\theta_1] = 64[\tan(25.95°) - 0] = 31.144\ \text{kVAR}$$

$$C = \frac{Q_c}{\omega V_{rms}^2} = \frac{31{,}144}{(2\pi)(60)(120)^2} = \underline{\mathbf{5.74\ mF}}$$