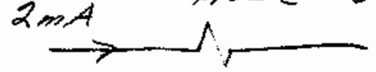
EE 211 Homework 1

2-28



$P_{max} = i^2 R = 2^2 \times 10^{-6} \times 493.5 = \underline{\boxed{1.9\,mW}}$

1/4 watt resistor would be fine. (2 mW resistor would work)

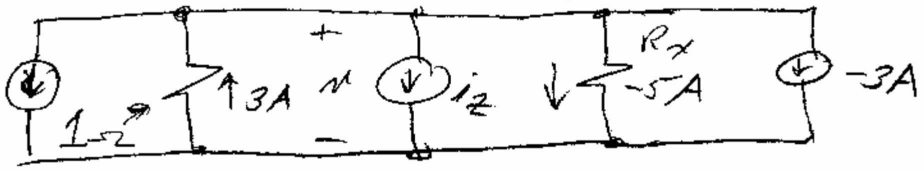
2-34

$v_s = 0.01 \cos 10^3 t = v_\pi$

dependant source current $= 10^{-5} \cos 10^3 t$

$\therefore \boxed{v = -10^{-2} \cos 10^3 t}$

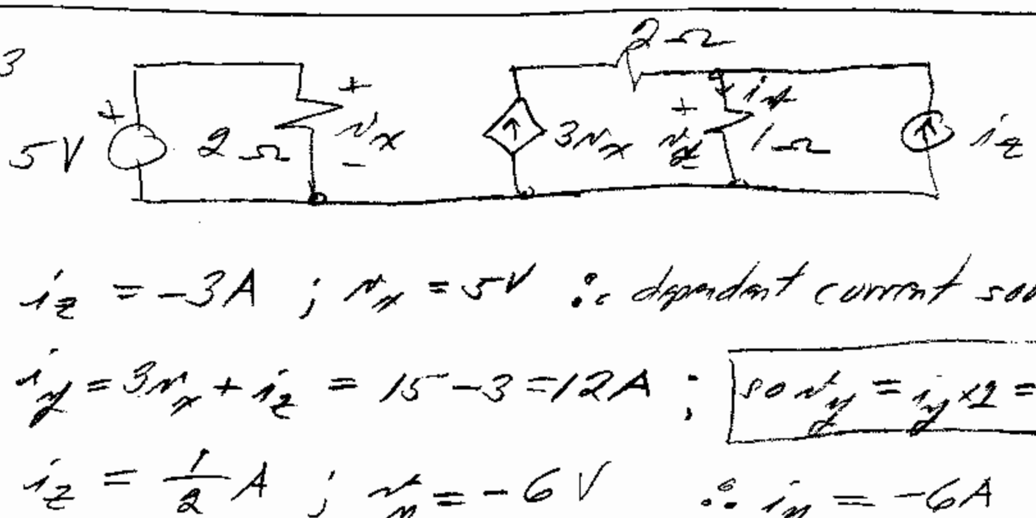
3-6



a) $2 - 3 + i_z - 5 - 3 = 0 \quad \therefore \boxed{i_z = 9A}$

b) $v = -3 \quad \therefore \boxed{R_x = \frac{v}{-5} = \frac{3}{5}\,\Omega}$

3-13



a) $i_z = -3A$; $v_x = 5V$ $\therefore$ dependant current source = 15A

$i_y = 3v_x + i_z = 15 - 3 = 12A$; $\boxed{\text{so } v_y = i_y \times 1 = 12V}$

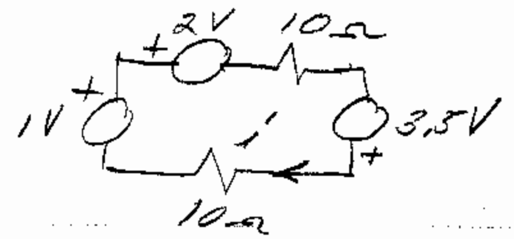
b) $i_z = \frac{1}{2} A$; $v_y = -6V \quad \therefore i_y = -6A$

KCL and $3v_x + i_z = -6$ or $v_x = -\frac{i_z}{3} - 2 = -\frac{1}{6} - 2$

$$\boxed{v_x = -\frac{13}{6} = -2.167\,V}$$

EE 211 Homework 2

3-16 a)

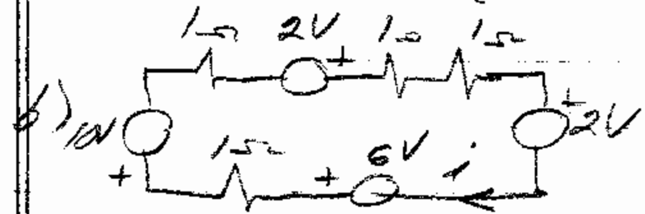


$-1+2+10i-3.5+10i=0$

$20i=2.5$

$\boxed{i=\frac{2.5}{20}=0.125}$

b)

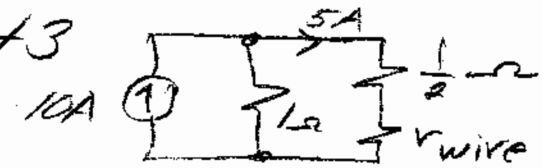


$10+i-2+i+i+2-6+i=0$

$4i=-4$

$\boxed{i=-1}$

3-43

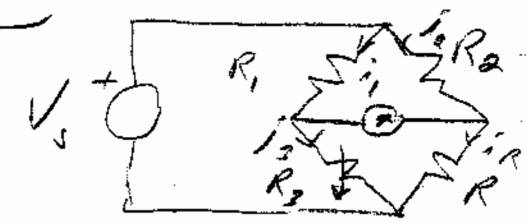


$\boxed{r_{wire}=\frac{1}{2}\,\Omega}$

(28 gauge wire 65.3 Ω/1000 ft)

$\frac{65.3}{1000}=\frac{0.5}{x}$ $\boxed{x=\frac{0.5\times1000}{65.3}=7.657\text{ ft}=1.45\times10^{-3}\text{ miles}}$

3-65



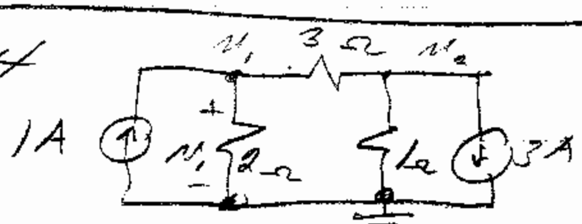
for balance $i_1R_1=i_2R_2$ (1)

and $i_3R_3=i_RR$ (2)

but $i_1=i_3$ + $i_2=i_R$

∴ dividing (1) by (2) gives $\frac{R_1}{R_3}=\frac{R_2}{R}$ or $\boxed{R=\frac{R_2R_3}{R_1}}$

4-4



$\frac{v_1}{2}+\frac{v_1-v_2}{3}=1$

$\frac{v_2-v_1}{3}+\frac{v_2}{1}=-3$

$\frac{5}{6}v_1-\frac{1}{3}v_2=1$

$-\frac{1}{3}v_1+\frac{4}{3}v_2=-3$

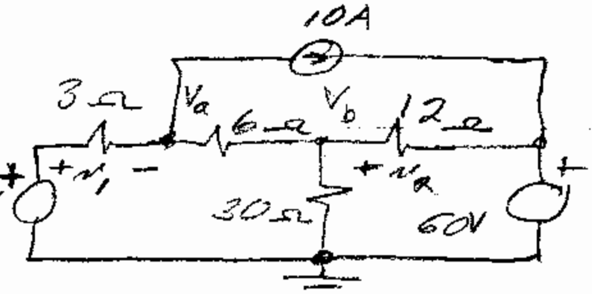
$\boxed{\begin{aligned}5v_1-2v_2&=6\\-v_1+4v_2&=-9\end{aligned}}$

$$\therefore v_1=\frac{\begin{vmatrix}6&-2\\-9&4\end{vmatrix}}{\begin{vmatrix}5&-2\\-1&4\end{vmatrix}}=\frac{24-18}{20-2}=\boxed{\frac{6}{18}=\frac{1}{3}V}$$

EE 211 Homework 3

$\frac{1}{3}+\frac{1}{6}=\frac{1}{2}$

4-9



$$\frac{V_a-240}{3}+\frac{V_a-V_b}{6}=-10$$

$$\frac{V_b-V_a}{6}+\frac{V_b}{30}+\frac{V_b-60}{12}=0$$

$$\frac{1}{6}+\frac{1}{30}+\frac{1}{12}=\frac{10+2+5}{60}=\frac{17}{60}$$

$$\left.\begin{aligned}\tfrac{1}{2}V_a-\tfrac{1}{6}V_b&=-10+80\\ -\tfrac{1}{6}V_a+\tfrac{17}{60}V_b&=5\end{aligned}\right\}\quad\begin{aligned}3V_a-V_b&=420\\ -10V_a+17V_b&=300\end{aligned}$$

$$V_a=\frac{\begin{vmatrix}420&-1\\300&17\end{vmatrix}}{\begin{vmatrix}3&-1\\-10&17\end{vmatrix}}=\frac{420(17)+300}{3(17)-10}=\frac{7440}{41}=181.46V$$

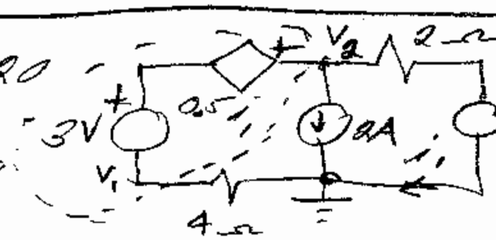
$$V_b=\frac{\begin{vmatrix}3&420\\-10&300\end{vmatrix}}{41}=\frac{900+4200}{41}=124.39V$$

$\therefore\ \boxed{v_1=240-V_a=58.54V}\ ;\ \boxed{v_2=V_b-60=64.39}$

$$P_{6\Omega}=\frac{(V_a-V_b)^2}{6}=\boxed{542.83\ \text{Watts}}$$

4-20

Super Node



$V_2-V_1=0.5i_1+3$

but $i_1=\frac{V_2-4}{2}$

$\therefore\ V_2-V_1=\frac{V_2}{4}-1+3\quad(1)$

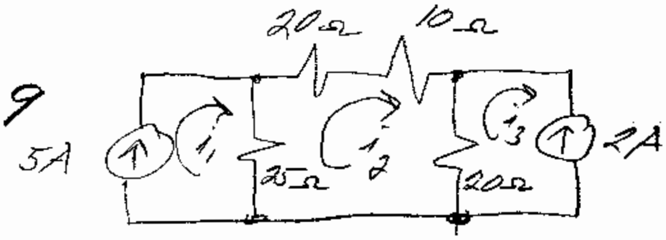
$$\left.\begin{aligned}&\text{@ super node}\quad \frac{V_1}{4}+\frac{V_2-4}{2}=-2\\ &\text{from (1)}\quad -V_1+\tfrac{3}{4}V_2=2\end{aligned}\right\}\begin{bmatrix}V_1+2V_2=0\\ -4V_1+3V_2=8\end{bmatrix}$$

$$V_1=\frac{\begin{vmatrix}0&2\\8&3\end{vmatrix}}{\begin{vmatrix}1&2\\-4&3\end{vmatrix}}=\frac{-16}{3+8}=-\frac{16}{11}\ ;\ V_2=\frac{\begin{vmatrix}1&0\\-4&8\end{vmatrix}}{11}=\frac{8}{11}V$$

$$i_1=\frac{V_2-4}{2}=\frac{\frac{8}{11}-\frac{44}{11}}{2}=-\frac{36}{22}=-\frac{18}{11}=\boxed{-1.636A}$$

EE 211 Homework 3 (page 2 solutions)

4-29



$i_1 = 5$

$i_3 = -2$

$(i_2 - i_1)25 + 30 i_2 + (i_2 - i_3)20 = 0$

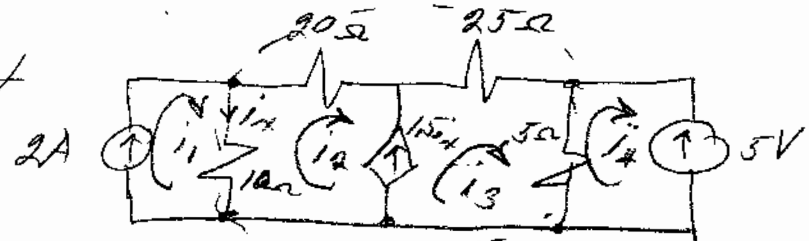
$75 i_2 = 125 - 40$

$$\boxed{i_2 = \frac{85}{75} = \frac{17}{15} = 1.133A}$$

$$\boxed{P_{25\Omega} = (i_1 - i_2)^2 \times 25 = 373.8 \text{ Watts}}$$

EE 211 Homework 4

4.34



supermesh

$\boxed{\begin{array}{l} i_1 = 2 \\ i_4 = -5 \end{array}}$

$1.5 i_x = i_3 - i_2$ (1)

$i_x = i_1 - i_2$ (2)

$(i_2 - i_1)10 + 20 i_2 + 25 i_3 + 5(i_3 - i_4) = 0$ (3)

combining (1) and (2) gives $\frac{3}{2}(i_1 - i_2) = i_3 - i_2$

∴ $- \frac{3}{2} i_2 + i_2 = -3 + i_3$

$-\frac{1}{2} i_2 = -3 + i_3$

or $\boxed{i_2 = 6 - 2i_3}$

∴ from (3) $30(6 - 2i_3) + 25 i_3 + 5 i_3 = -5$

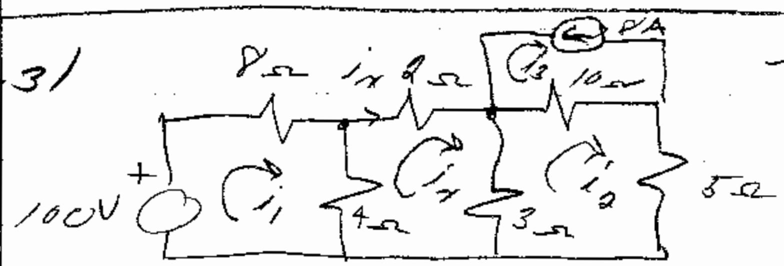
$-30 i_3 = -5 - 180 = -185$

$\left[i_3 = \frac{185}{30} = \frac{37}{6} = 6.167 \text{ A} \right]$

and $\boxed{i_2 = 6 - 2i_3 = -6.333}$

so $\boxed{i_x = i_1 - i_2 = 2 + 6.333 = 8.333}$

4-31



$i_3 = -8$

$-100 + 8i_1 + 4(i_1 - i_x) = 0$

$4(i_x - i_1) + 2i_x + 3(i_x - i_2) = 0$

$3(i_2 - i_x) + 10(i_2 + 8) + 5 i_2 = 0$

$12 i_1 - 4 i_x = 100$

$-4 i_1 + 9 i_x - 3 i_2 = 0$

$-3 i_x + 18 i_2 = -80$

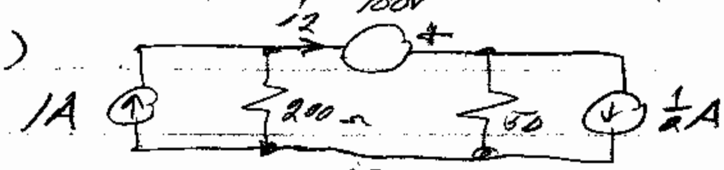
4-31 continued

$$i_x = \frac{\begin{vmatrix} 12 & 100 & 0 \\ -4 & 0 & -3 \\ 0 & -10 & 18 \end{vmatrix}}{\begin{vmatrix} 18 & -4 & 0 \\ -4 & 7 & -3 \\ 0 & -3 & 18 \end{vmatrix}} = \frac{12(-240) - 100(-72)}{12(162-9) + 4(-72)}$$

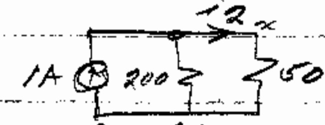
$$\boxed{i_x = \frac{4320}{1548} = 2.79\ A}$$

EE 211 Homework 5

5.9 a)

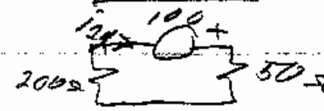


for 1A source



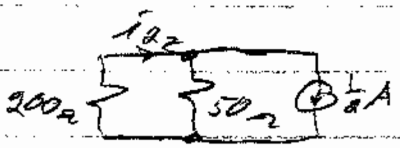
$i_{2x} = 1 \cdot \frac{200}{250} = \frac{4}{5}A$

for 100V source



$i_{2y} = \frac{100}{250} = \frac{2}{5}A$

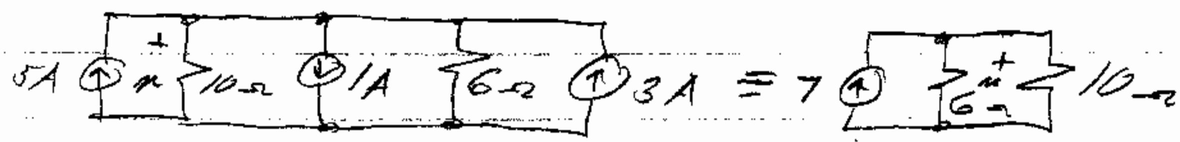
for $\frac{1}{2}$A source

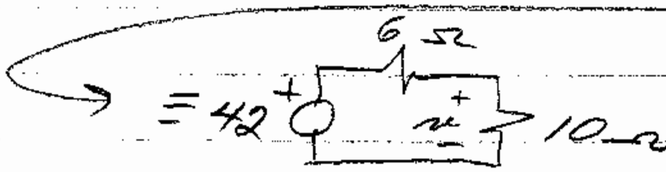


$i_{2z} = \frac{1}{2} \cdot \frac{50}{250} = \frac{1}{10}A$

$$\therefore \boxed{i_2 = i_{2x} + i_{2y} + i_{2z} = \frac{13}{10}A = 1.3A}$$

5.21



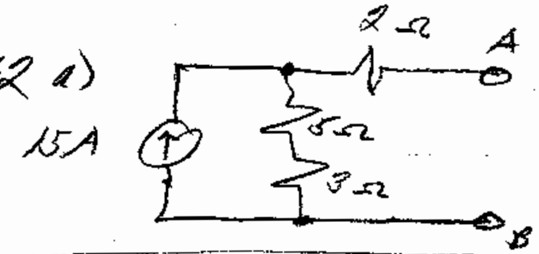


$$\boxed{v = 42\frac{10}{16} = 26.25V}$$

b) If we include 10Ω resistor the voltage v is no longer present?

EE 211 Homework 6

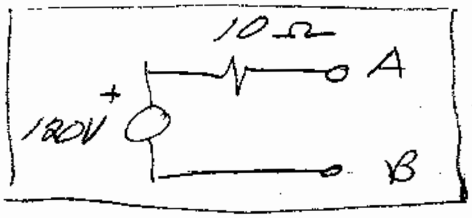
5-42 a)



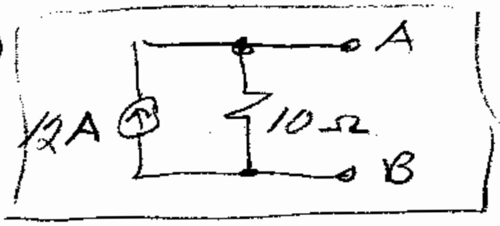
$V_{oc} = V_{Th} = 15 \times 8 = \boxed{120V}$

$I_{sc} = \cancel{15}^{3} \frac{8}{\cancel{10}_{2}} = 12A$

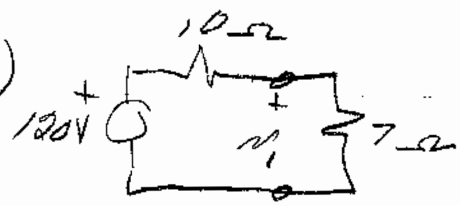
$\therefore R_{Th} = \frac{V_{oc}}{I_{sc}} = \boxed{10\ \Omega}$



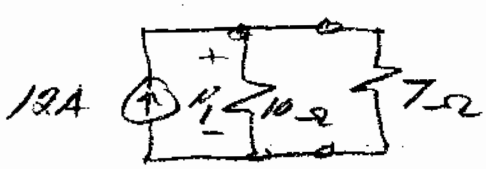
b)



c)

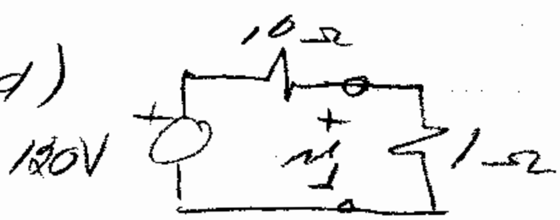


$\boxed{v_1 = 120 \times \frac{7}{17} = 49.41\ V}$



$\boxed{v_1 = 12\,\frac{70}{17} = 49.41V}$

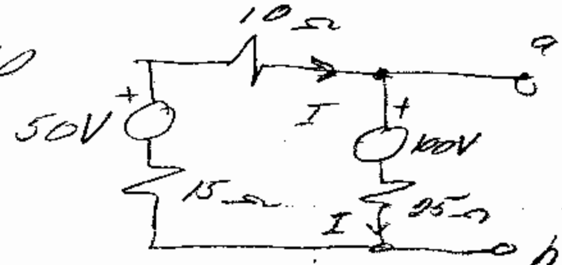
d)



$\boxed{v_1 = 200\,\frac{1}{11} = 18.18\ V}$

EE 211 Homework 7

5-40



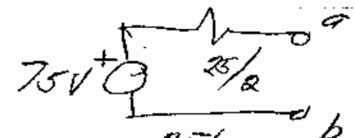
a) for $V_{oc} = V_{Th}$

$-50 + 100 + I\,50 = 0$

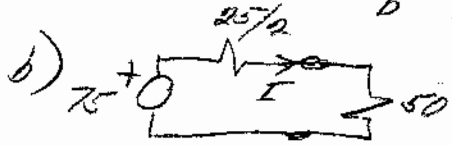
$I = -1$

$\therefore \boxed{V_{oc} = V_{Th} = 75V}$

$\boxed{R_{eq} = R_{Th} = \frac{25}{2}}$



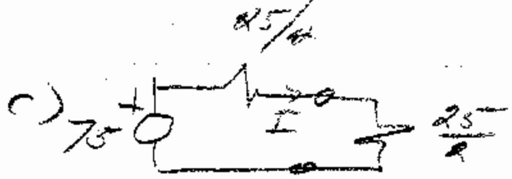
b)



$I = \frac{75}{\frac{125}{2}} = \frac{150}{125} = \frac{30}{25} = \frac{6}{5} A$

$\therefore P_{50\Omega} = \left(\frac{6}{5}\right)^2 50 = \frac{36 \times 50}{25} \boxed{= 72W}$

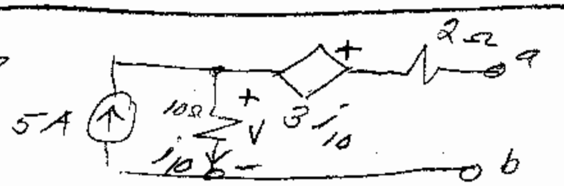
c)



$I = \frac{75}{50/2} = \frac{150}{50} = 3$

$P_{\frac{25}{2}\Omega} = I^2 \times \frac{25}{2} = \frac{9 \times 25}{2} = \boxed{112.5W}$

5-63

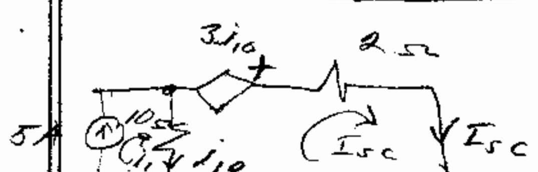


for V_{oc} $V = 50V$

$i_{10} = 5A$

$\therefore \boxed{V_{oc} = V_{Th} = 3i_{10} + V = 65V}$

15



$(I_{sc} - 5)10 - 3(5 - I_{sc}) + I_{sc}2 = 0$

$I_{sc}(15) = 65 \; ; \; I_{sc} = \frac{65}{15} = \frac{13}{3}$

$\therefore \boxed{R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{65 \times 3}{13} = \frac{195}{13}\Omega = 15\Omega}$

for maximum power $R_L = R_{Th}$; $P_{max} = \frac{V_{Th}^2 R_{Th}}{4R_{Th}^2} = \frac{V_{Th}^2}{4R_{Th}}$

so $\boxed{P_{max} = \frac{65^2}{4 \times 15} = 70.4 \text{ Watts}}$

EE 211 Homework 8

7.1 $\boxed{10\mu F}$ a) $v = 5V$ ∴ $\boxed{i = C\frac{dv}{dt} = 0}$

b) $v = 115\sqrt{2}\cos 120\pi t$ $i = 115\sqrt{2}\times10^{-5}\times120\pi\sin 120\pi t$

or $i = -0.613\sin 120\pi t$

c) $v = 4e^{-t}\times10^{-3}$; $\boxed{i = -4\times10^{-8}e^{-t}}$

7.13

for $t \geq 0$ $w_c = \frac{1}{2}Cv^2 = 20e^{-10^3 t}\times10^{-3}$

∴ $v^2 = \frac{40}{10^{-6}}e^{-10^3 t}\times10^{-3}$

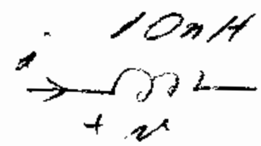
$v = \pm 200e^{-500t}$

$i = C\frac{dv}{dt} = \pm10^{-6}\times(200)\times(-500)e^{-500t} = \mp 0.1e^{-500t}$

$\boxed{R = -\frac{v}{i} = +\frac{200}{0.1} = 2\times10^{3}\Omega}$

$w_R = \int_0^\infty vi\,dt = \int_0^\infty 20e^{-10^3 t}dt = \frac{20}{-10^3}e^{-10^3 t}\Big|_0^\infty = \boxed{0.02J}$

7.15



a) $i = 5mA$; $v = L\frac{di}{dt} = 0$

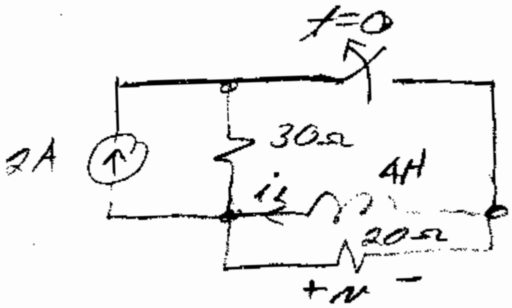
b) $i = 115\sqrt{2}\cos 120\pi t$; $v = 10^{-8}\times115\sqrt{2}(-1)120\pi\sin 120\pi t$

$\boxed{i = -6.13\times10^{-4}\sin 120\pi t}$

c) $i = 4e^{-6t}$; $v = 10^{-8}\times4(-6)e^{-6t} = \boxed{-24\times10^{-8}e^{-6t}}$

EE 211 Homework 9

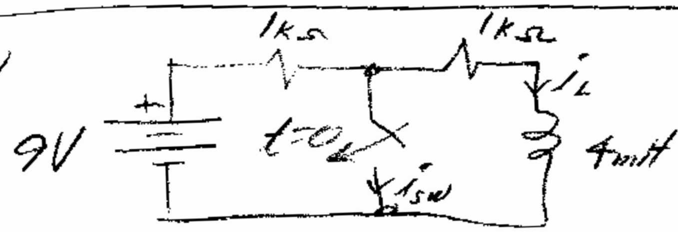
8.6



a) $i_L(0^-) = i_L(0^+) = 2A$

b) $v(0^+) = 2 \times 20 = 40V$

8.8



$i_L(0^-) = i_L(0^+) = \frac{9}{2 \times 10^3}$

for $t > 0$ $\quad i_L \times 10^3 + 4 \times 10^{-3} \frac{di_L}{dt} = 0$

$i_L = Ae^{s_1 t} \Rightarrow 10^3 + 4 \times 10^{-3} s_1 = 0$

$s_1 = -\frac{10^3}{4 \times 10^{-3}} = -\frac{1}{4} \times 10^6$

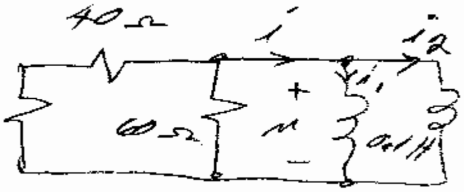
$\therefore \boxed{i_L = \frac{9}{2} \times 10^{-3} e^{-\frac{t \times 10^6}{4}}}$

a) $t = 5\mu s \quad i_L = \frac{9}{2} \times 10^{-3} e^{-\frac{5}{4}} = 1.289 \times 10^{-3}$

b) $i_{sw}(t = 5 \times 10^{-6}) = -i_L + \frac{9}{10^{+3}} = \boxed{7.71 \times 10^{-3}}$

EE 311 Homework 10

8-35

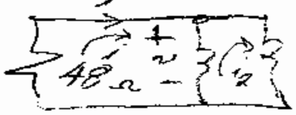


$i_1(0^-) = 10A$

$i_2(0^-) = 20A$

a) $\boxed{i_1(0^+) = 10A}$; $\boxed{i_2(0^+) = 20A}$ $\therefore$ $\boxed{i(0^+) = 30A}$ ←

b) $R_{eq} = \dfrac{240 \times 60}{300} = 48\,\Omega$



had not discussed R_{eq}

Mesh currents

$48i + 0.1\frac{d}{dt}(i - i_2) = 0$; $\underbrace{0.4\frac{di_2}{dt} + 0.1\frac{d}{dt}(i_2 - i) = 0}_{0.5\frac{di_2}{dt} = +0.1\frac{di}{dt}}$

combining these two equation: $48i + 0.1\frac{di}{dt} - 0.1(+0.2)\frac{di}{dt} = 0$

or $0.08\frac{di}{dt} + 48i = 0$: $i = Ae^{st}$; $0.08s = -48$; $s = -600$

$\left[\tau = \frac{1}{s} = 1.67 \times 10^{-3} = 1.67\,msec\right]$ ←

c) $\boxed{i(t) = 30e^{-600t}}$ ←

d) $v(t) = -48i(t) = \boxed{-1440e^{-600t}}$ ←

e) $i_1(t) = 10\int_0^t(-1440)e^{-600t}dt + 10 = \frac{-14400}{-600}e^{-600t}\Big|_0^t + 10$

or $\boxed{i_1(t) = 24e^{-600t} - 14}$ ←

$i_2(t) = 2.5\int_0^t(-1440e^{-600t})dt + 20 = \boxed{6e^{-600t} + 14}$ ←

f) Energy delivered to $R_{eq} = \int_0^\infty i^2 R_{eq}\,dt = \int_0^\infty 900e^{-1200t} \times 48\,dt = W_R$

or $W_R = 36J$ ←

$W_L(t=0) = \frac{1}{2}(0.1)\times 10^2 + \frac{1}{2}(0.4)20^2 = 5 + 80 = 85J$ ←

$W_L(t=\infty) = \frac{1}{2}(0.1)\times 14^2 + \frac{1}{2}(0.4)14^2 = \frac{14^2}{4} = 49J$ ←

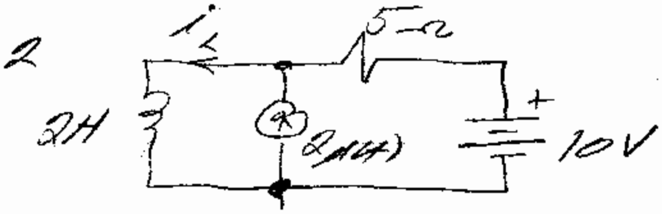
? does $W_L(t=0) \overset{?}{=} W_R + W_L(t=\infty)$

$85 \overset{?}{=} 36 + 49$

$85 = 85$

EE 211 Homework 11

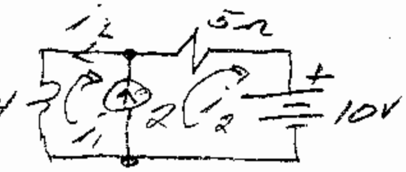
8.62



$i_L(0) = \frac{10}{5} = 2A$

a) @ $t = -0.5s$; $\boxed{i_L = 2A}$

b) for for $t > 0$



$\boxed{i_2 - i_1 = 2}$ (1)

$\boxed{i_1 = -i_L}$

use a supermesh equation $2\frac{di_1}{dt} + 5i_2 = -10$ (2)

combining (1) + (2) gives: $2\frac{di_1}{dt} + 5(2+i_1) = -10$

or $\frac{di_1}{dt} + \frac{5}{2}i_1 = -10$

$i_{1_{homo}} = Ae^{st}$; $s = -\frac{5}{2}$ so $i_{1_{homo}} = Ae^{-\frac{5}{2}t}$

$i_{1_{part}} = K$ so $\frac{5}{2}K = -10$; $K = -4$

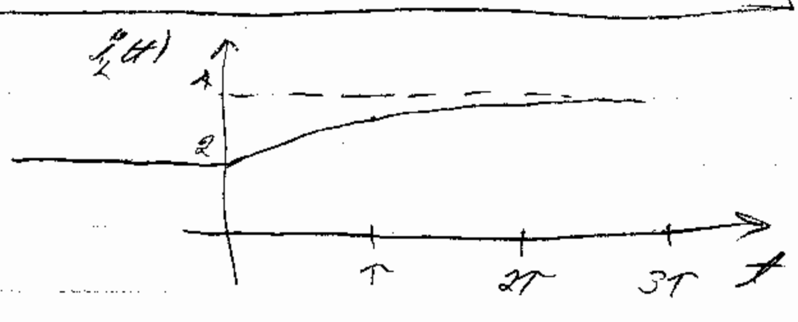
$i_L = -i_1 = -i_{1_{homo}} - i_{1_{part}} = -Ae^{-\frac{5}{2}t} + 4$

but $i_L(0) = 2 = -A + 4$ ∴ $A = 2$

and $\boxed{i_L(t) = -2e^{-\frac{5}{2}t} + 4}$

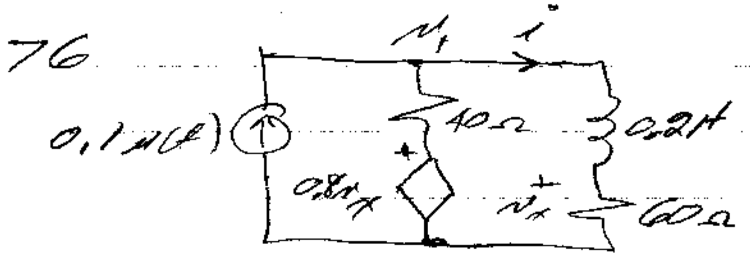
$\boxed{i_L(0.5) = 4 - 2e^{-\frac{5}{4}} = 3.427A}$

c) $\boxed{i_L(1.5s) = 4 - 2e^{-\frac{15}{4}} = 3.953A}$



EE 211 Homework 12

9-76



$\boxed{\text{for } t<0}$

current source $=0$

$\therefore v_x = 0$

$\boxed{\text{and } i=0}$

for $t>0$ $\begin{cases} \dfrac{v_1 - 0.8v_x}{40} + 5\int_0^t (v_1 - v_x)\,dt = 0 \\ 5\int_0^t (v_x - v_1)\,dt + \dfrac{v_x}{60} = 0 \end{cases}$ Node Equations

Mesh $\rightarrow$ $0.2\dfrac{di}{dt} + 60i - 0.8v_x + (i-0.1)40 = 0$

but $v_x = 60i$

so we have $\boxed{\dfrac{1}{5}\dfrac{di}{dt} + 52i = 4}$ $\leftarrow$

$i_h = Ae^{st}$; $\frac{1}{5}s + 52 = 0$ so $s = -52\times 5 = -260$

$i_p = K$ so $52K = 4$ or $K = \frac{4}{52}$

$i = i_h + i_p = Ae^{-260t} + \frac{4}{52}$ but $i(0)=0$ so $A = -\frac{4}{52}$

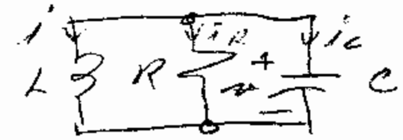
$i = \frac{4}{52}(1-e^{-260t})u(t)$

$v_x = 60i = \frac{240}{52}(1-e^{-260t})u(t)$

or $v_x = 4.615(1-e^{-260t})u(t)$ $\leftarrow$

EE 211 Homework 13

$L=5,\ R=8,\ C=12.5\times10^{-3}$

9.10  $v(0+)=40V$

a) $i(0+)=8A$ $\quad \frac{v}{R}+C\frac{dv}{dt}+\frac{1}{L}\int_0^t v\,dt+8=0 \qquad (1)$

or $\frac{d^2v}{dt^2}+\frac{1}{RC}\frac{dv}{dt}+\frac{v}{LC}=0$; $v=Ae^{st}$

$s^2+\frac{1}{RC}s+\frac{1}{LC}=0 \quad \therefore \quad s_{1,2}=-\frac{1}{2RC}\pm\sqrt{\left(\frac{1}{2RC}\right)^2-\frac{1}{LC}}$

so $s_{1,2}=-\underbrace{\frac{10^3}{2\times8\times12.5}}_{5}\pm\sqrt{25-16}=-5\pm3=-2,-8$

$\therefore \quad v(t)=A_1e^{-2t}+A_2e^{-8t}$ but $v(0)=40$ so $\boxed{A_1+A_2=40}$

from (1) above $\left.\frac{dv}{dt}\right|_{t=0}=\frac{-8}{C}-\frac{40}{RC}=-640-400=-1040$

so $+2A_1+8A_2=+1040$ or $2(40-A_2)+8A_2=1040$

$6A_2=1040-80$; $A_2=160$ $\therefore A_1=-120$

giving: $\boxed{v(t)=-120e^{-2t}+160e^{-8t}}$

b) $i_C(0)=8A$; $v(0)=40$; so $i_R(0)=5$

$i(t)=A_3e^{-2t}+A_4e^{-8t}$ but $i(0)=-i_R(0)-i_C(0)=-13$

so $\boxed{-13=A_3+A_4}$ also $v(0)=L\left.\frac{di}{dt}\right|_{t=0}=40$; $\left.\frac{di}{dt}\right|_{t=0}=8$

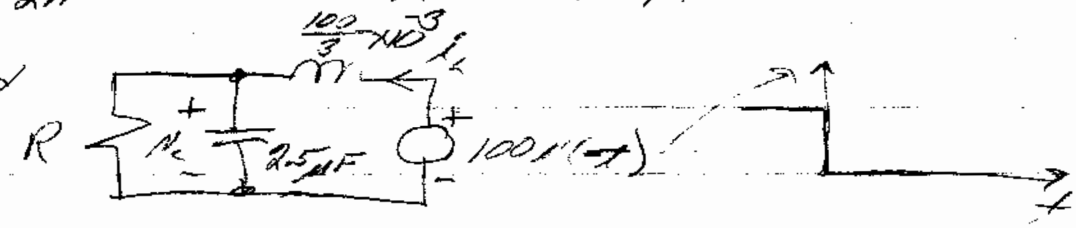
so $8=-2A_3-8A_4=-2(-A_4-13)-8A_4=-6A_4+26$

$\therefore A_4=3$ and $A_3=-16$

giving: $\boxed{i(t)=-16e^{-2t}+3e^{-8t}}$

EE 211 Homework 14

9.28



$i_L(0) = \frac{100}{R}$; $v_c(0) = 100$

for $t > 0$ we have parallel RLC circuit $\therefore$

$$\frac{v_c}{R} + C\frac{dv_c}{dt} + \frac{1}{L}\int_0^t v_c\,dt - i_L(0) = 0 \qquad (1)$$

or $\frac{d^2v_c}{dt^2} + \frac{1}{RC}\frac{dv_c}{dt} + \frac{1}{LC}v_c = 0$; $v_c = Ae^{st}$; $s^2 + \frac{1}{RC}s + \frac{1}{LC} = 0$

$$\therefore \quad s_{1,2} = -\frac{1}{2RC} \pm \sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}$$

for critical damping $\left(\frac{1}{2RC}\right)^2 = \frac{1}{LC}$; $\frac{1}{2RC} = \frac{1}{\sqrt{LC}}$

$$R = \frac{\sqrt{LC}}{2C} = \frac{1}{2}\sqrt{\frac{L}{C}} = \frac{1}{2}\sqrt{\frac{0.1\times10^6}{3\times2.5}} \boxed{= 57.73\,\Omega}$$

$$s = -\frac{1}{2RC} = -\frac{10^6}{2\times57.735\times2.5} = -3464$$

so $v_c(t) = A_1 e^{-3464t} + A_2 t e^{-3464t}$.

but $v_c(0) = 100$ so $\boxed{A_1 = 100}$

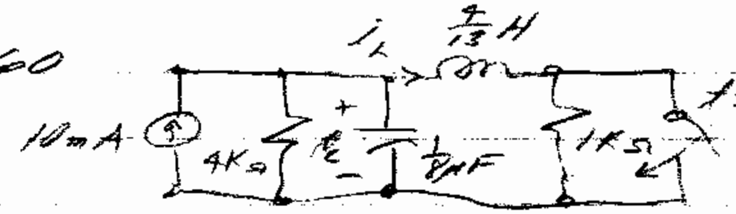
from (1) above $\left.\frac{dv_c}{dt}\right|_{t=0} = -\frac{1}{RC}v_c(0) + \frac{100}{RC} = 0\,!$

$\therefore (-3464)\times100 + A_2 = 0 \quad \therefore A_2 = +3.464\times10^5$

and $\boxed{v_c(t) = 100e^{-3464t} + 3.464\times10^5\,te^{-3464t}}$

EE 211 Homework 15

9.60



$v_c(0) = 10^{-2} \times \frac{4}{5} \times 10^3$

or $\boxed{v_c(0) = 8V}$

$\boxed{i_L(0) = 10^{-2} \times \frac{4}{5}}$

for $t>0$ we have:

$$\frac{v_c}{4\times10^3} + \frac{1}{8}\times10^{-6}\frac{dv_c}{dt} + \frac{13}{4}\int_0^t v_c\,dt + \frac{4}{5}\times10^{-2} = 10^{-2} \qquad (1)$$

differentiating $\boxed{\times 8\times10^6}$ $\boxed{\frac{d^2v_c}{dt^2} + 2\times10^3\frac{dv_c}{dt} + 26\times10^6 = 0}$

for $v_c = Ae^{st}$ we have $s^2 + 2\times10^3 s + 26\times10^6 = 0$

$S_{1,2} = -10^3 \pm \sqrt{10^6 - 26\times10^6} = \boxed{-10^3 \pm j5\times10^3}$

$\therefore v_c(t) = A_1 e^{-10^3 t}\cos 5\times10^3 t + A_2 e^{-10^3 t}\sin 5\times10^3 t$

but $v_c(0) = 8 \quad \therefore \quad \boxed{A_1 = 8}$

from (1) above $\frac{8}{4\times10^3} + \frac{1}{8}\times10^{-6}\left.\frac{dv_c}{dt}\right|_{t=0} + \frac{4}{5}\times10^{-2} = 10^{-2}$

so $\left.\frac{dv_c}{dt}\right|_{t=0} = 8\times10^6\left(\underbrace{10^{-2} - \frac{4}{5}\times10^{-2}}_{0.2\times10^{-2} = 2\times10^{-3}} - 2\times10^{-3}\right) = 0$

$\therefore \quad 8(-10^3) + A_2(5\times10^3) = 0 \;;\; \boxed{A_2 = \frac{8\times10^3}{5\times10^3} = \frac{8}{5}}$

and $v_c(t) = 8e^{-10^3 t}\cos 5\times10^3 t + \frac{8}{5}e^{-10^3 t}\sin 5\times10^3 t$

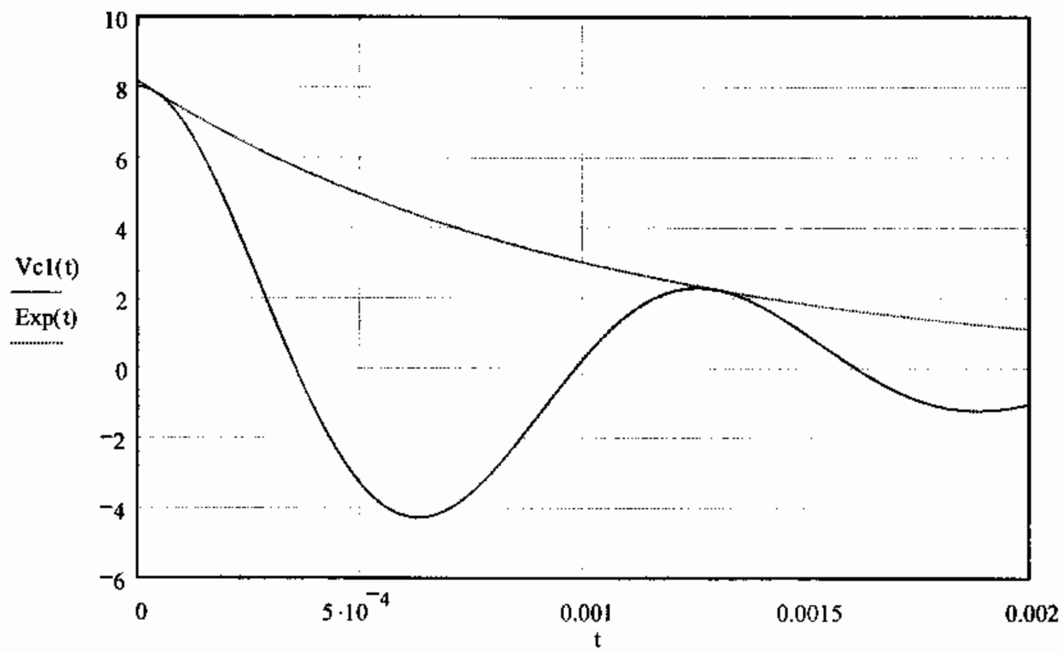
b) See attached plot

EE 211 Hayt problem 9.60

$t := 0, 10^{-8} .. 2 \times 10^{-3}$

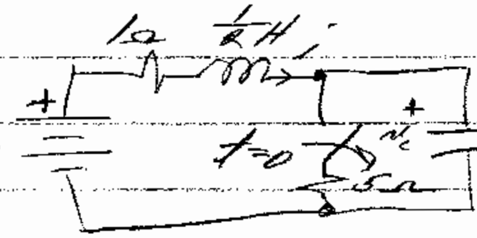
$$Vc(t) := e^{-1000 \cdot t}\left(\frac{8}{5} \cdot \sin(5000 \cdot t) + 8 \cdot \cos(5000 \cdot t)\right)$$

$$Exp(t) := \left[\sqrt{8^2 + \left(\frac{8}{5}\right)^2}\right] \cdot e^{-1000 \cdot t} \qquad Vc1(t) := Exp(t) \cdot \cos\left(5000 \cdot t - \operatorname{atan}\left(\frac{1}{5}\right)\right)$$



EE 211 Homework 16

9-61



$i(0) = \frac{12}{6} = 2A$

$v_c(0) = \frac{5}{6} \times 12 = 10V$

for $t>0$ $\quad 12 = i + \frac{1}{2}\frac{di}{dt} + \frac{1}{2}\int_0^t i\,dt + 10 \qquad (1)$

or $\frac{d^2i}{dt^2} + 2\frac{di}{dt} + i = 0$ for $i = Ae^{st}$

we have $s^2+2s+1=0$ $\quad s_{1,2} = \frac{-2\pm\sqrt{4-4}}{2} = -1$

$\therefore i = A_1 e^{-1t} + A_2 t e^{-1t}$ but $i(0)=2$ $\therefore \boxed{A_1 = 2}$

from (1) $\left.\frac{di}{dt}\right|_{t=0} = \frac{12-10-2}{1/2} = 0 = -A_1 + A_2$

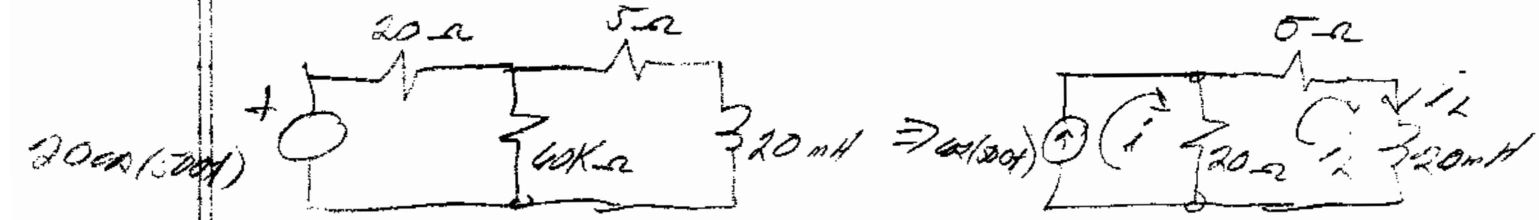
$\therefore A_2 = 2$

and $\boxed{i(t) = 2e^{-t} + 2te^{-t}}$

$v_c(t) = 12 - i - \frac{1}{2}\frac{di}{dt} = 12 - 2e^{-t} - 2te^{-t} - \frac{1}{2}[\cancel{-2e^{-t}}$
$+2t(-1)e^{-t} + \cancel{2e^{-t}}]$

$\boxed{v_c(t) = 12 - 2e^{-t} - te^{-t}}$

EE 211 Homework 17



Use current source $= 1 e^{j500t}$ then all currents and voltages will be of the form $\left.\begin{matrix}\hat{V}\\ \hat{I}\end{matrix}\right\} \times e^{j500t}$

Using mesh currents as here

$$20\times(\hat{I}_L - 1)\cancel{e^{j500t}} + 5\hat{I}_L \cancel{e^{j500t}} + j10\,\hat{I}_L \cancel{e^{j500t}} = 0$$

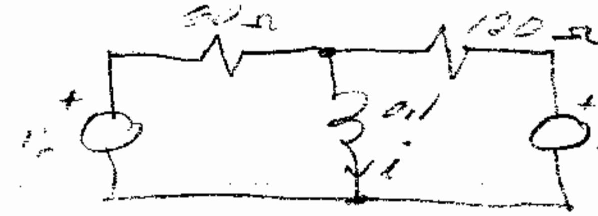
$$\hat{I}_L = \frac{20}{25+j10} = \frac{20}{26.92\,e^{j21.8^\circ}}$$

$$\hat{I}_L = 0.743\,e^{-j21.8^\circ}$$

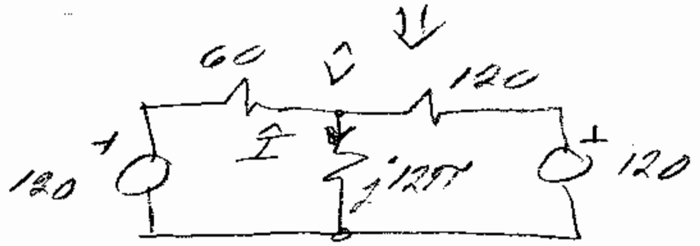
$$i_L = \mathrm{Re}\{\hat{I}_L e^{j500t}\} = \underline{0.743\cos(500t - 21.8^\circ)} \leftarrow$$

EE 211 Homework 18

10.18



$v_s = 120 \cos 120\pi t$



$$\frac{\hat{V}-120}{60} + \frac{\hat{V}}{j12\pi} + \frac{\hat{V}-120}{120} = 0$$

$$\hat{V}\left(\frac{1}{60} + \frac{1}{120} - j\frac{1}{12\pi}\right) = 1 + 2 = 3$$

$$\hat{V} = \frac{3}{\frac{3}{120} - j\frac{1}{12\pi}} = \frac{3 \times 120\pi}{3\pi - j10}$$

$$\hat{I} = \frac{\hat{V}}{j12\pi} = \frac{-j30}{3\pi - j10} = \frac{30}{10 + j3\pi} = \frac{30}{13.74 e^{j43.3^\circ}}$$

$$i(t) = 2.183 \cos(120\pi t - 43.3^\circ)$$

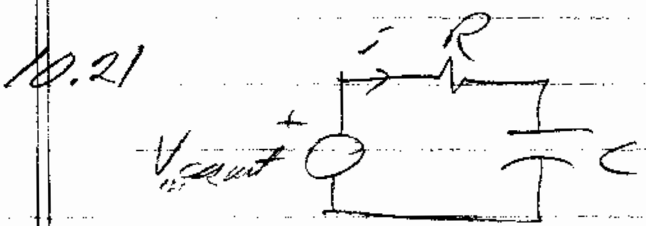
$$W_L = \frac{1}{2} L i^2 = 0.238 \cos^2(120\pi t - 43.3^\circ) \text{ J}$$

or $W_L = 0.119\left[1 + \cos(240\pi t - 86.6^\circ)\right]$

$\therefore W_{L_{ave}} = 0.119$ Joules

EE 211 Homework 19

10.21



$$V_m \cos\omega t = iR + \frac{1}{C}\int_0^t i\,dt + v_c$$

a) or $-V_m \omega \sin\omega t = R\frac{di}{dt} + \frac{1}{C} i$

b) $i_p = A\cos\omega t + B\sin\omega t$

$\therefore \quad -V_m \omega \sin\omega t = R\{-\omega A \sin\omega t + \omega B\cos\omega t\}$
$\qquad + \frac{1}{C}\{A\cos\omega t + B\sin\omega t\}$

coefficients of cos + sin must be equal so:

$$-V_m\omega = -\omega RA + \frac{B}{C} \quad + \quad \underbrace{0 = \omega RB + \frac{A}{C}}_{B = -\frac{A}{\omega RC}}$$

giving $+V_m\omega = +\omega RA + \frac{A}{\omega RC^2} \Rightarrow A = \dfrac{V_m\omega}{\omega R + \frac{1}{\omega RC^2}}$

$$\text{or } A = \frac{V_m\omega^2 RC^2}{\omega^2R^2C^2+1} \;;\quad B = -\frac{V_m\omega C}{\omega^2R^2C^2+1}$$

$$i_p = \frac{V_m\omega C}{\omega^2R^2C^2+1}\{\omega RC\cos\omega t - \sin\omega t\}$$

but $A\cos\omega t - B\sin\omega t = K\cos(\omega t + \phi) = K\cos\omega t\cos\phi - \sin\omega t\sin\phi$

$K\cos\phi = A \qquad K = \sqrt{A^2+B^2}\;;\; \phi = \tan^{-1}\frac{B}{A}$

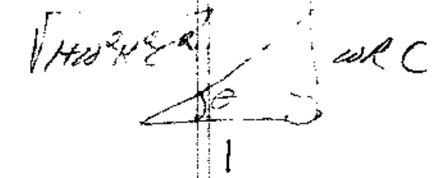
$+K\sin\phi = B$

$$\text{so } i_p = \frac{V_m\omega C}{\omega^2R^2C^2+1}\sqrt{1+\omega^2R^2C^2}\cos\left[\omega t + \tan^{-1}\left(\frac{1}{\omega RC}\right)\right]$$

Check on problem 10.21

$$\hat{I} = \frac{V_m}{R+\frac{1}{j\omega C}} = \frac{V_m j\omega C}{1+j\omega RC}$$

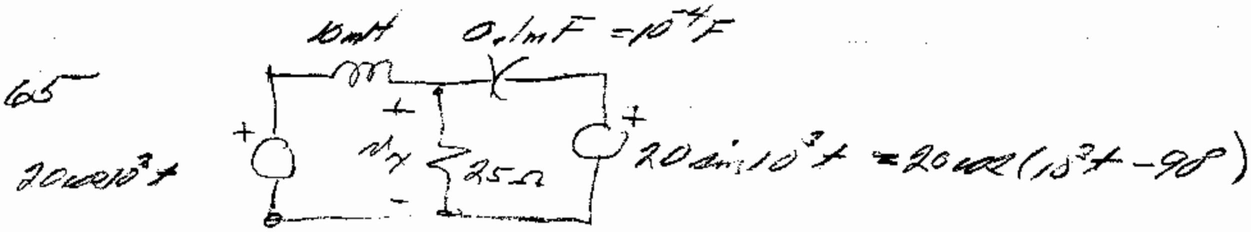
$$\therefore\ i(t) = \frac{V_m \omega C}{\sqrt{1+\omega^2R^2C^2}} \cos\left[\omega t \underbrace{- \tan^{-1}(\omega RC) + 90^\circ}_{+\tan^{-1}\left(\frac{1}{\omega RC}\right)}\right]$$



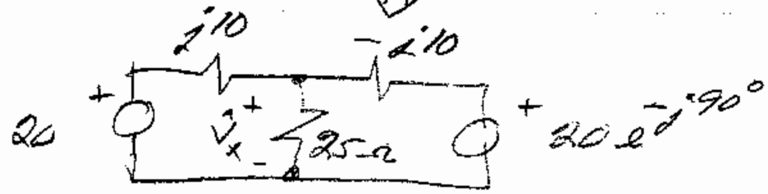
QED

EE 211 Homework 20

10.65



⇓



$$\frac{\hat{V}_x - 20}{j10} + \frac{\hat{V}_x}{25} + \frac{\hat{V}_x - 20e^{-j90^\circ}}{-j10} = 0$$

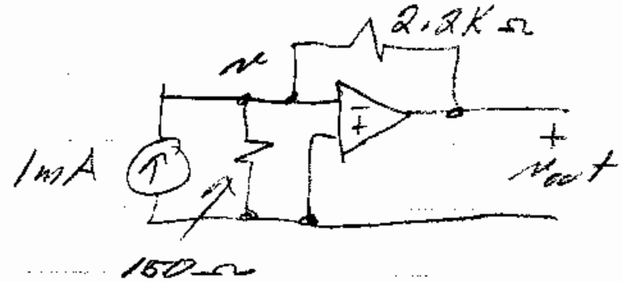
$$\frac{\hat{V}_x}{25} = \frac{20}{j10} - \frac{20}{j10}e^{-j90^\circ} \Rightarrow \hat{V}_x = 25\left(\frac{\overset{2}{\cancel{20}}}{j\cancel{10}}\right)\left(1 - e^{-j90^\circ}\right)$$

$$\hat{V}_x = 50\,(1 - \underbrace{e^{-j90^\circ}}_{-j})(-j) = 50(1-j) = 50\sqrt{2}\,e^{-j45^\circ}$$

$$\therefore\ v_x(t) = 50\sqrt{2}\cos(10^3 t - 45^\circ) \leftarrow$$

EE 211 Homework 22

6.13

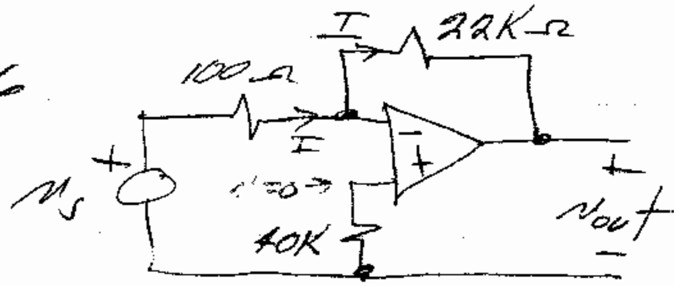


$$\frac{v}{150} + \frac{v - v_{out}}{2.2 \times 10^3} = 10^{-3}$$

$\boxed{\text{but } v = 0}$

$\therefore \boxed{v_{out} = -2.2 \text{ Volts}}$

6.16



no current through 40K Ω resistor ∴ voltage at positive input terminal is zero!

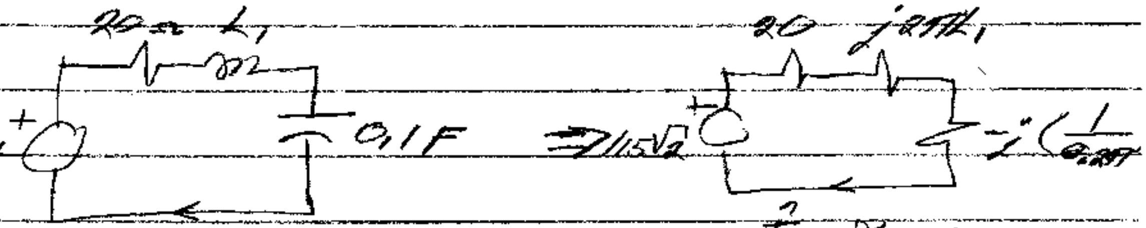
so $v_s = 100 I$ or $I = \frac{v_s}{100}$

and $v_{out} = -I \times 22 \times 10^3$

$$\therefore v_{out} = -\frac{v_s}{10^2} \times 22 \times 10^3 = -220 v_s$$

EE 211 Homework 21

10.74



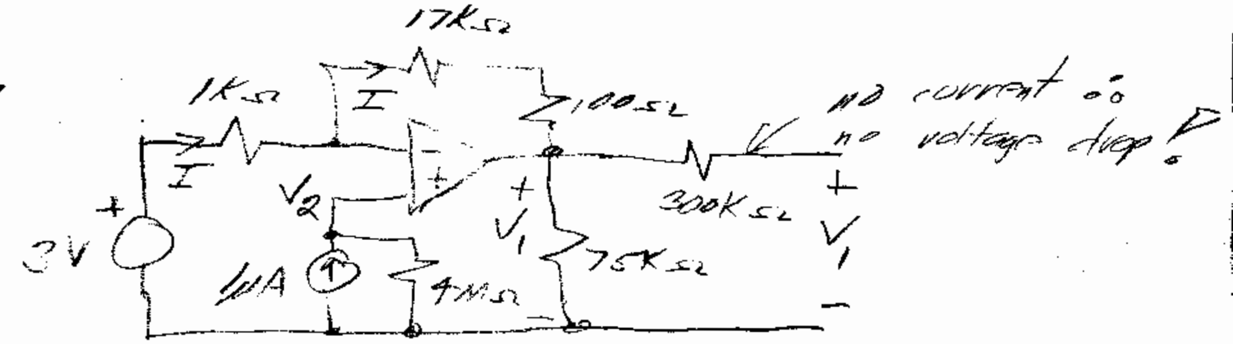
$i_1(t) = 8.132 \cos 2\pi t$ $\quad \hat{I}_1 = 8.132$

Current $i_1(t)$ and source are in phase. Therefore, the impedance of the RLC circuit must be real.

$\therefore \quad 2\pi L_1 = \frac{1}{0.2\pi} \quad ; \boxed{L_1 = \frac{1}{0.4\pi^2} = 0.2533 H}$

EE 211 Homework 23

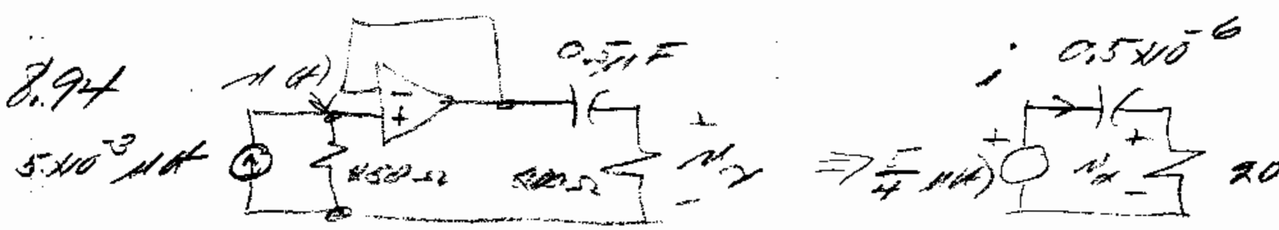
6.17



$\boxed{V_2 = 10^{-6}\times 4\times 10^{6} = 4\text{ Volts}}$; $-3 + 10^3 I + 4 = 0$ or $\boxed{I = -10^{-3}}$

$V_1 = -I\times 17.1\times 10^3 + 4 = 17.1 + 4 = \boxed{21.1\text{ Volts}}$

8.94



$u(t) = 5\times 10^{-3}\times 0.25\times 10^{3} = \frac{5}{4}u(t)$ $\quad\tau = RC = \frac{1}{2}\times 2\times 10^{-4}$

for $t<0$ $v_{source} = 0$ ∴ $\boxed{v_{cap}(0) = 0}$

for $t>0$ $\frac{5}{4} = 200i + 2\times 10^{6}\int_0^t i\,dt$ (1)

or $200\frac{di}{dt} + 2\times 10^{6} i = 0 \Rightarrow \frac{di}{dt} + 10^4 i = 0$

$i = Ae^{st}$; $s = -10^4$

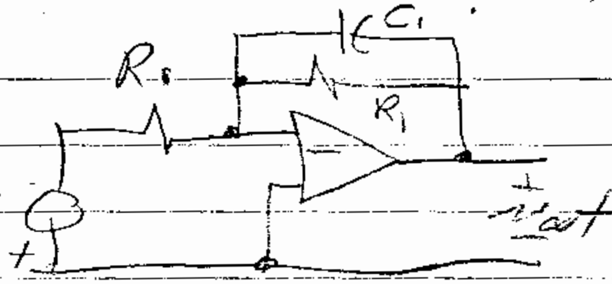
∴ $i = Ae^{-10^4 t}$ $= A$

from (1) above $\frac{5}{4} = 200i(0)$ or $i(0) = \frac{5}{800} = \frac{1}{160}$

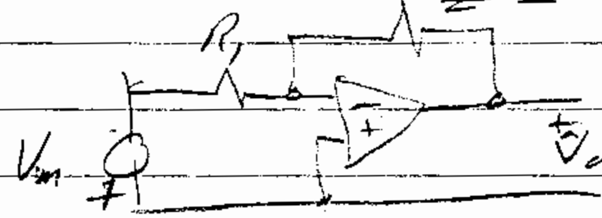
$$\boxed{\text{and } v_x = 200i = \frac{5}{4}e^{-10^4 t}}$$

EE 211 Homework 24

10.20



$\Downarrow$



$$Z = \frac{R_1 \frac{1}{j\omega C_1}}{R_1 + \frac{1}{j\omega C_1}} = \frac{R_1}{1 + j\omega R_1 C_1}$$

$$\hat{V}_{out} = +V_m\left(\frac{1}{1+j\omega R_1 C_1}\right)$$ inverting amp $\text{Gain} = \frac{Z_f}{Z_{in}}$

or $$\hat{V}_{out} = +\frac{V_m\, e^{-j\tan^{-1}(\omega R_1 C_1)}}{\sqrt{1+\omega^2 R_1^2 C_1^2}}$$

$$\therefore\; v_{out}(t) = +\frac{V_m}{\sqrt{1+\omega^2 R_1^2 C_1^2}} \cos\left[\omega t - \tan^{-1}(\omega R_1 C_1)\right]$$

or $$v_{out}(t) = \frac{V_m}{\sqrt{1+\omega^2 R_1^2 C_1^2}} \cos\left[\omega t - \tan^{-1}(\omega R_1 C_1)\right] \Leftarrow$$

If $R_1 C_1 = \frac{L}{R}$ and we multiply by R to get $v_R(t)$ =

$$v_R(t) = \frac{V_m R}{\sqrt{1+\omega^2 \left(\frac{L}{R}\right)^2}} \cos\left[\omega t - \tan^{-1}\left(\omega \frac{L}{R}\right)\right] = \frac{V_m}{\sqrt{R^2+\omega^2 L^2}} \cos\left[\omega t - \tan^{-1}\left(\frac{\omega L}{R}\right)\right]$$

which is the solution given in equation [4] page 373

EE 211 Homework 25

10-31 $\boxed{\text{wanted } 6\text{-}31}$

a) $12e^{j(110^\circ-90^\circ)} = \boxed{12e^{j20^\circ}}$

b) $-7\sin 800t - 3\cos 800t = -K\cos(800t - \phi)$

$K = \sqrt{49+9} = 7.616$; $\phi = \tan^{-1}\left(\frac{7}{3}\right) = 66.8^\circ$

so $-7\sin 800t - 3\cos 800t = -7.616\cos(800t - 66.8^\circ)$

or phasor is $\boxed{7.616\, e^{j113.2^\circ}}$

c) $4\cos(200t - 30^\circ) - 5\cos(200t + 20^\circ)$

phasor $= 4e^{-j30^\circ} - 5e^{j20^\circ} = 3.464 - j2 - 4.698 - j1.710$

$= -1.234 - j3.710 = \boxed{3.91\, e^{-j108.3}}$

d) $\omega = 600$; $t = 5$ msec

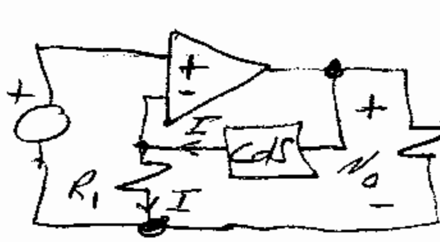
$70e^{j30^\circ} \Rightarrow 70\cos(600t + 30^\circ)\Big|_{t=5\text{msec}} = \boxed{-64.95}$

$\hat{V} = -60 + j40 = 72.11\, e^{j146.31^\circ}$

$72.11\cos(\overbrace{600t}^{3\text{rad}} + 146.31^\circ)\Big|_{t=5\text{msec}} = \boxed{53.75}$

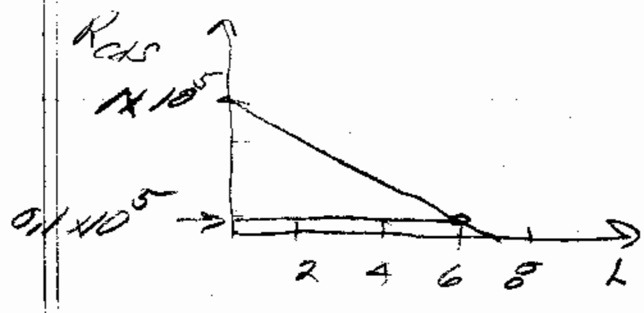
EE 211 Homework 26

6-31



CdS cell
no light $R = 10^5\,\Omega$
6 candela $R = 10^4\,\Omega$

→ 2 candela produces $v_o = 1.5V$ ←



$slope = -\frac{\cancel{0.9}\,0.3 \times 10^5}{\cancel{6}\,2} = -0.15\times10^5$

$\therefore\ \boxed{R_{CdS} = -15\times10^3 L + 10^5}$

$I = \frac{v_s}{R_1}$; $v_{out} = I(R_1 + R_{CdS}) = v_s\left(1 + \frac{R_{CdS}}{R_1}\right)$ ←

for $L = 2$ candela $R_{CdS} = -30\times10^3 + 100\times10^3 = \underline{70\times10^3}$

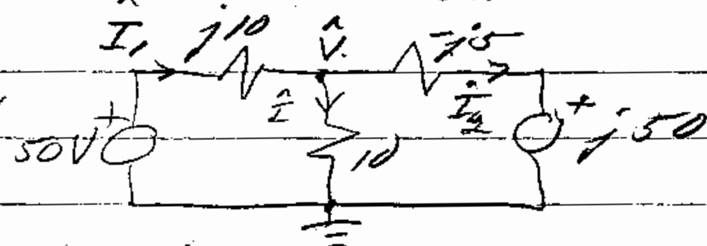
$\therefore\ \boxed{1.5 = v_s\left(1 + \frac{70\times10^3}{R_1}\right)}$ ←

if we pick $R_1 = 10k\,\Omega$

then $1.5 = v_s(1+7)$ or $v_s = \frac{1.5}{8} = \boxed{0.1875 V}$

EE 211 Homework 27

11.14



$$\frac{\hat{V}-50}{j10}+\frac{\hat{V}}{10}+\frac{\hat{V}-j50}{-j5}=0 \Rightarrow \hat{V}\left(-j\frac{1}{10}+\frac{1}{10}+j\frac{1}{5}\right)=-j5-10$$

$$\therefore \hat{V}=\frac{-10-j5}{\frac{1}{10}+j\frac{1}{10}}=-10\left\{\frac{10+j5}{1+j}\right\}=\frac{10e^{j180^\circ}\,11.18e^{j26.56^\circ}}{\sqrt{2}\,e^{j45^\circ}}$$

$$\hat{V}=79.0e^{j161.56^\circ};\quad \boxed{\text{so } \hat{I}=\frac{\hat{V}}{10}=7.9e^{j161.56^\circ}}$$

$$\hat{I}_1=\frac{50-\hat{V}}{j10}=\frac{50(1+j)+100+j50}{j10(1+j)}=\frac{150+j100}{-10+j10}=\frac{15+j10}{-1+j}=\frac{18.03e^{j33.69}}{\sqrt{2}\,e^{j135}}$$

$$\therefore \boxed{\hat{I}_1=12.75e^{-j101.31}}$$

$$\hat{I}_2=\frac{\hat{V}-j50}{-j5}=\frac{-100-j50-j50(1+j)}{(1+j)(-j5)}=\frac{-50-j100}{5-j5}=\frac{-10-j20}{1-j}$$

$$\hat{I}_2=\frac{22.36e^{j243.43}}{\sqrt{2}\,e^{-j45^\circ}}=\boxed{15.81e^{j71.57^\circ}}$$

$$P_{ave_{50V}}=-\frac{1}{2}Re\{50\times 12.75e^{+j101.31}\}=+62.51 \text{ Watts}$$

$$P_{ave_{j50V}}=\frac{1}{2}Re\{j50\times 15.81e^{-j71.57}\}=-374.98 \text{ Watts}$$

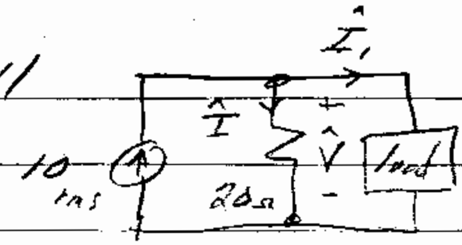
$$P_{ave_{10\Omega}}=\frac{1}{2}|\hat{I}|^2 10=312.05 \text{ Watts}$$

$$P_{ave_{inductor}}=P_{ave_{capacitor}}=0$$

$$\Sigma P_s=-0.42\approx 0$$

EE 211 Homework 27 (page 2)

11.41



a) $\hat{I}_{rms} = 4e^{j35^\circ}$

$\hat{I}_1 = 10 - 4e^{j35^\circ}$

$\therefore \hat{I}_1 = 10 - 3.277 - j2.294 = 6.723 - j2.294 = 7.10e^{-j18.84}$

$\hat{V} = \hat{I} \times 20 = 80e^{j35^\circ}$

Power

So $P_{source} = -Re\{80e^{j35^\circ} \times 10\} = -80 \times 10 \times \cos 35^\circ = \boxed{-655.3 \text{ Watts}}$

$P_{20\Omega} = Re\{\hat{V}\hat{I}^*\} = Re\{320\} = \boxed{320 \text{ Watts}}$

$P_{load} = Re\{\hat{V}\hat{I}_1^*\} = Re\{80e^{j35} \times 7.1e^{+j18.84}\} = \boxed{335.14 \text{ Watts}}$

$\boxed{\Sigma = -0.16 \approx 0}$

Apparent Power

$AP_{source} = -10 \times 80 = -800$ Volt Amperes

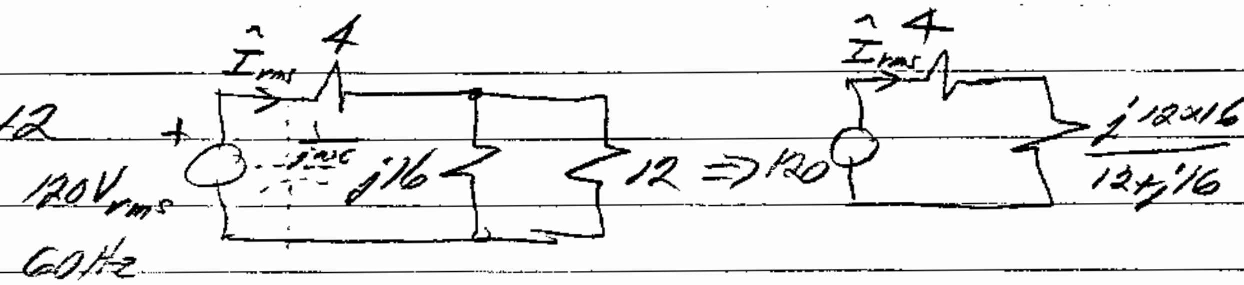
$AP_{20\Omega} = 320$ Volt Amperes

$AP_{load} = 80 \times 7.1 = 568$ Volt Amperes

$pf \text{ load} = \frac{Power}{AP} = \frac{335.14}{568} = \boxed{0.59 \text{ lagging}}$

EE 211 Homework 28

11.42



a) or $\hat{I}_{rms} = \frac{120}{4+\frac{j192}{12+j16}} = \frac{120(12+j16)}{48+j256} = \frac{120(\frac{3}{4}+j)}{3+j16}$

$\hat{I}_{rms} = \frac{90+j120}{3+j16} = \frac{150e^{j53.13^\circ}}{16.279e^{j79.38}} = 9.210e^{-j26.25^\circ}$

$\therefore$ source $\boxed{pf = 0.897 \text{ lagging}}$

b) $P_{ave_{source}} = -Re\{120\times 9.21e^{+j26.25}\} = \boxed{-991.2 \text{ Watts}}$

c) $\hat{S}_{circuit} = \hat{V}_{rms}\hat{I}^*_{rms} = 120\times 9.210e^{+j26.25} = 991.2 + j488.82$

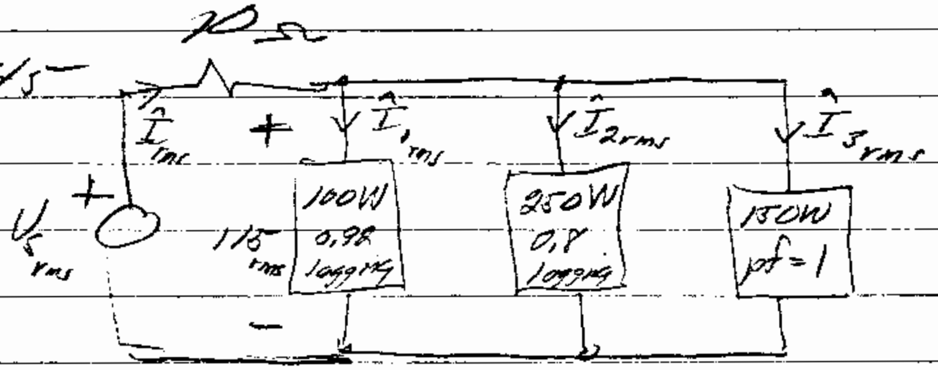
$\therefore$ Capacitor Q must be $-j488.82$ for $pf = 1$

$Q_{cap} = 120\,\hat{I}^*_{cap} = 120\times120(-j2\pi\times60C)$

$$\boxed{C = \frac{488.82}{120^2\times2\times\pi\times60} = 90\times10^{-6}\,F}$$

EE 211 Homework 29

11.45



$P = V_{rms} I_{rms} (pf)$

$$\hat{I}_{rms} = \frac{100}{115 \times 0.92} e^{-j23.07^\circ} + \frac{250}{115 \times 0.8} e^{-j36.87^\circ} + \frac{150}{115}$$

$$\hat{I}_{rms} = 0.945\, e^{-j23.07^\circ} + 2.717\, e^{-j36.87} + 1.304$$

$$\hat{I}_{rms} = 0.869 - j0.37 + 2.174 - j1.63 + 1.304 = 4.347 - j2$$

or $\boxed{\hat{I}_{rms} = 4.78\, e^{-j24.7^\circ}}$

$\boxed{pf = \cos 24.7^\circ = 0.9084 \text{ lagging}}$