EE 202 - HW3 Solutions.

8.8) $V_1 = 5+5j = 5\sqrt{2}\angle 45^\circ \Rightarrow v_1(t) = 5\sqrt{2}\cos(\omega t + 45^\circ)$ V

$V_2 = 3(8-j6) = 30\angle -36.8 \Rightarrow v_2(t) = 30\cos(\omega t - 36.8^\circ)$ V

$I_1 = 12 + j5 - 5/j = 12\angle 0 \Rightarrow i_1(t) = 12\cos(\omega t)$ mA

$I_2 = \dfrac{330 + j810}{2200 - j560} = \dfrac{874.6\angle 67.8}{2270.1\angle -14.3} = 0.385\angle 82.1 \Rightarrow i_2(t) = 0.385\cos(\omega t + 82.1^\circ)$ A

8.9) (a) $V_1 = 10\angle 90^\circ \Rightarrow V_2 = \frac{1}{100} j(\overset{\omega}{100}) V_1 + 20V_1 = (20+j)10\angle 90^\circ = 200.2\angle 92.8^\circ$

$\Rightarrow v_2(t) = 200.2\cos(100t + 92.8^\circ)$

(b) $I_1 = 4\angle 180^\circ \Rightarrow I_2 = \dfrac{10}{j5_{\leftarrow\omega}} I_1 - 3I_1 = (-j2-3)4\angle 180^\circ = 14.4\angle 33.7^\circ$

$\Rightarrow v_2(t) = 14.4\cos(5t + 33.7^\circ)$

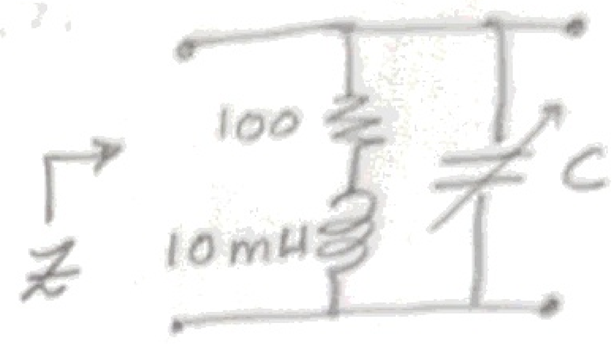
8.27) $\omega = 10^3$ rad/s

Both Z & Y should be real values.

$Y = \frac{1}{Z} = j\omega C + \dfrac{1}{100 + j\omega L}$

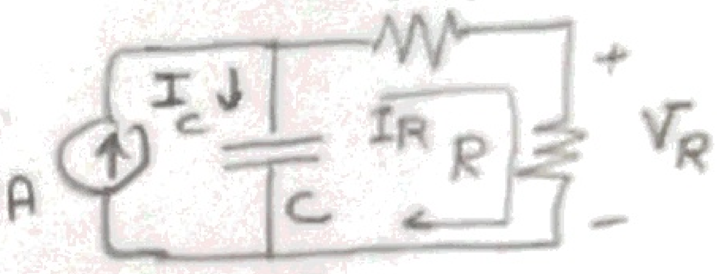
$= j1000C + (0.0099 - 0.00099j)$

$\hookrightarrow$ imaginary $= 0 \Rightarrow C = 0.99\times 10^{-6}$ F

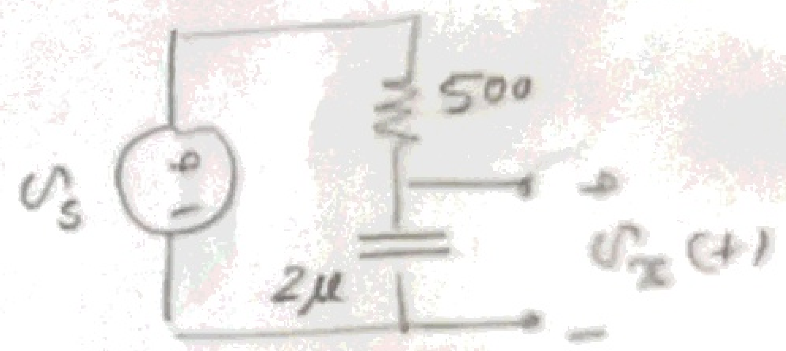


8.37) We can use current division formula consisting of two branches, one C and another one 3R, to find branch currents.

$I_c = I_A \dfrac{3R}{3R + 1/j\omega c} = \dfrac{jI_A 3R\omega c}{1 + j\omega 3RC}$ & $V_R = RI_R = R\dfrac{1/j\omega c}{3R + 1/j\omega c} I_A = \dfrac{RI_A}{1 + j\omega 3RC}$



8.46)(a) Using transfer function $H(j\omega) = \dfrac{V_x}{V_s} = \dfrac{1/j\omega c}{1/j\omega c + R}$, we can plug the element values and given frequencies to carry out v_x phasor:



1) $\omega = 1500$ & $V_m = 5 \Rightarrow V_{x_1} = 5\angle 0 \times \dfrac{1}{1 + j1500\times 2\times 10^{-6}\times 500} = 2.77\angle -56.3^\circ$

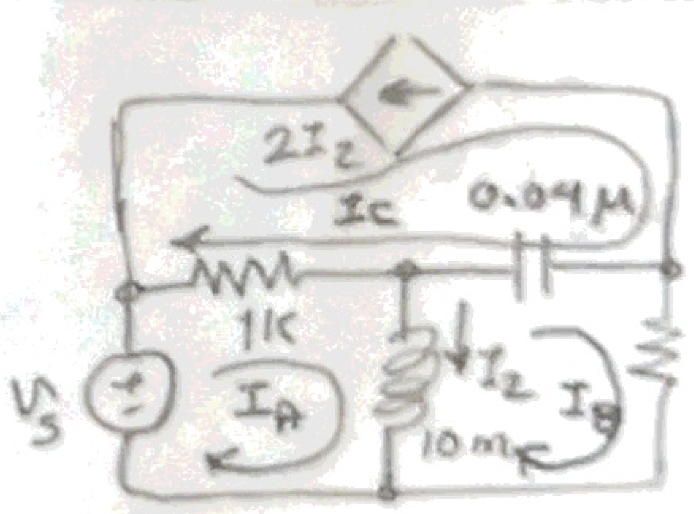
2) $\omega = 500$ & $v_m = 10 \Rightarrow V_{x_2} = 10\angle 0 \dfrac{1}{1 + j500\times 2\times 10^{-6}\times 500} = 8.94\angle -26.5^\circ$

$\Rightarrow v_x(t) = 2.77\cos(1500t - 56.3^\circ) + 8.94\cos(500t - 26.5^\circ)$

8.68) $v_s(t) = 100\sin(10^4 t) \Rightarrow V_s = 100e^{-j\pi/2} = 100\angle -90^\circ$

Using mesh analysis: $\begin{cases} V_s = 1K(I_A - I_C) + j\omega L(I_A - I_B) \\ -j\omega L(I_A - I_B) + 1/j\omega c\,(I_B - I_c) + 2K I_B = 0 \\ I_c = -2(I_A - I_B) \end{cases}$

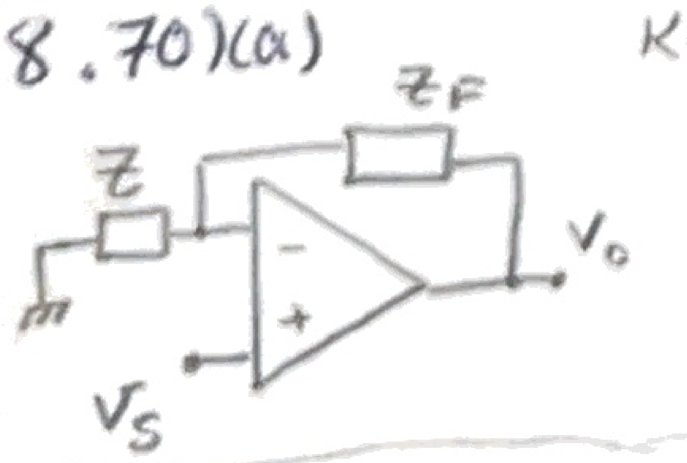
$*\ I_c = -2I_2$



$\Rightarrow \begin{cases} -100j = (3000 + 100j)I_A - (2000 + 100j)I_B \\ (2000 + 2600j)I_B - 5100jI_A = 0 \end{cases} \Rightarrow \begin{cases} I_A = 0.049\angle -18.17^\circ \\ I_B = 0.077\angle 19.39^\circ \end{cases} \Rightarrow I_c = 0.096\angle 58.05^\circ$

$\Rightarrow I_1 = I_A - I_c = 0.097\angle -92.4^\circ$ & $I_2 = I_A - I_B = 0.048\angle -121.9^\circ$ & $I_3 = I_B$

8.70)(a)

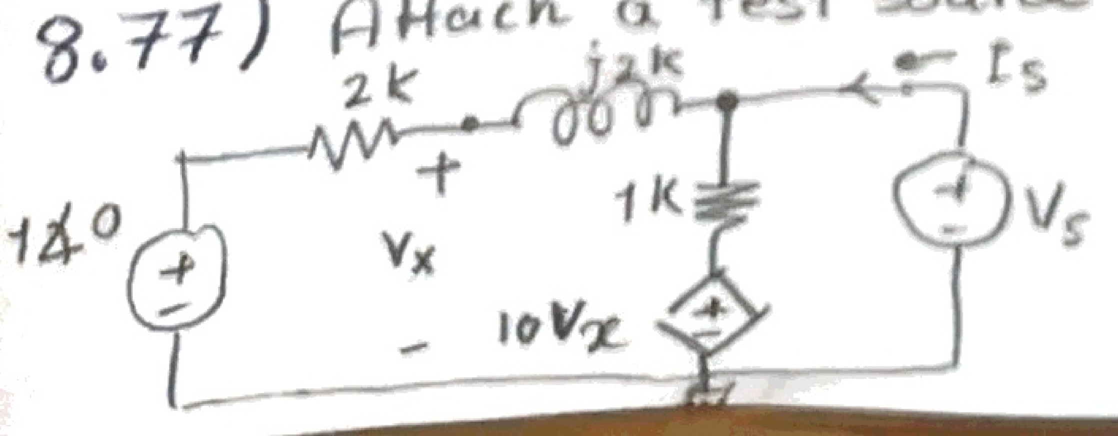


KCL @ negative terminal assuming op-amp in linear mode: $V_s/Z = (V_o - V_s)/Z_F$

$\Rightarrow \dfrac{V_o}{V_s} = \dfrac{(Z + Z_F)}{Z}$, where $\begin{cases} Z_F = R_2 \\ Z = R_1 + 1/j\omega c \end{cases} \Rightarrow \dfrac{V_o}{V_s} = \dfrac{R_2 + R_1 + 1/j\omega c}{R_1 + 1/j\omega c} = \dfrac{(R_1 + R_2)j\omega c + 1}{R_1 j\omega c + 1}$

$= \left(\dfrac{R_1 + R_2}{R_1}\right)\left(\dfrac{j\omega + \frac{1}{c(R_1+R_2)}}{j\omega + \frac{1}{R_1 C}}\right)$

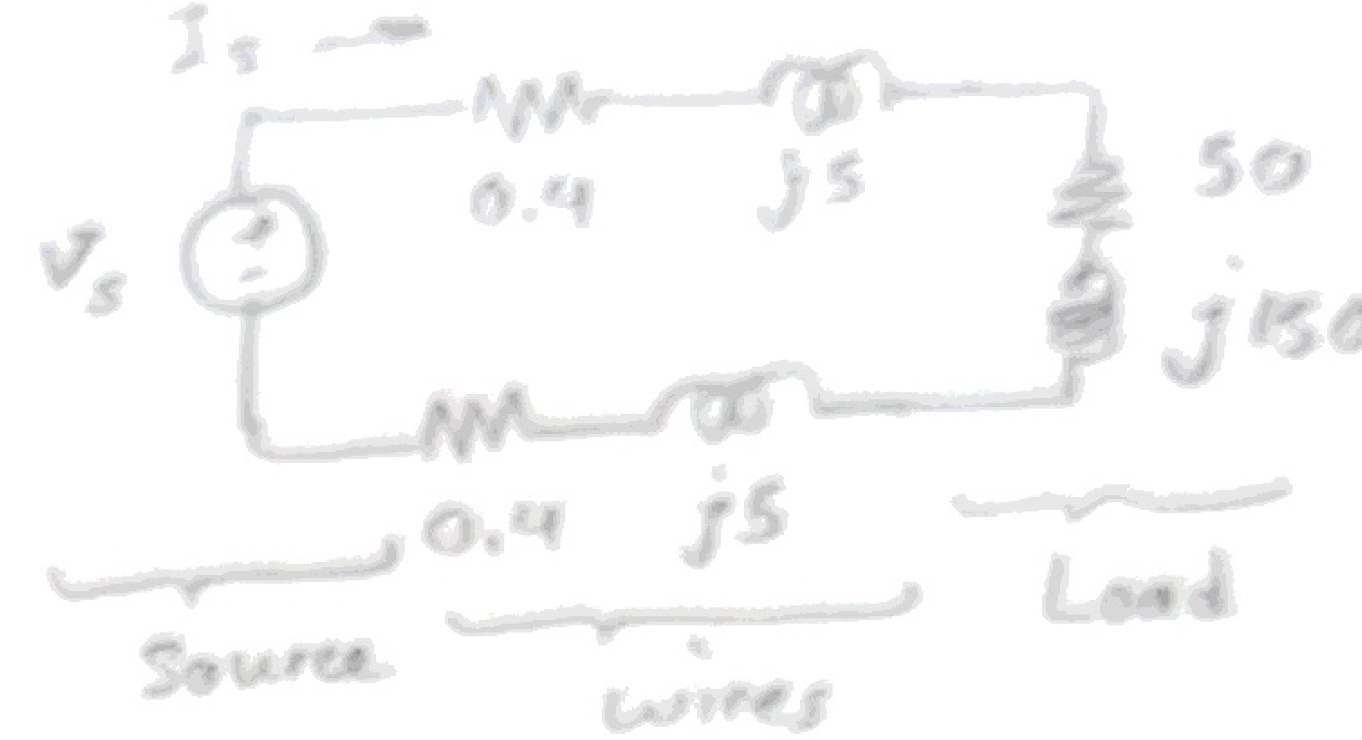
8.77) Attach a test source V_s and find related I_s. Writing KCL at input:



$\dfrac{V_s - 10V_x}{1k} + \dfrac{V_s - 1\angle 0}{2k + j2k} = I_s$ $\longrightarrow$ $V_s = \underbrace{(0.078 - j1.16)}_{V_T} + \underbrace{(-0.102 - j0.13)}_{Z_T\,(k\Omega)} I_s$

KCL @ V_x: $\dfrac{V_x - 1\angle 0}{2k} = \dfrac{V_s - V_x}{j2k} \Rightarrow V_x = \dfrac{(1+j)}{2}(1 - jV_s)$

8.93) $V_s = 880\angle 0$



$$I_s = \frac{V_s}{0.4\times 2 + j5\times 2 + 50 + j150} = 5.24\angle -72.38 \text{ A}$$

$$P_{wire} = \frac{1}{2}|I_s|^2 Re\{Z_{wire}\} = \frac{1}{2}\times 5.242^2\times(0.4\times 2) = 10.991$$

$$P_{Load} = \frac{1}{2}|I_s|^2 Re\{Z_{Load}\} = \frac{1}{2}\times 5.242^2\times 50 = 686.996$$

$$P_{soure} = Re\{\tfrac{1}{2}V_s I_s^*\} = Re\{\tfrac{1}{2}880\times 5.242\angle +72.38\} = 697.988$$

$$\Rightarrow \eta = P_{Load}/P_{source} = 98.4\%$$

* It is seen that : $P_{source} = P_{wire} + P_{Load}$