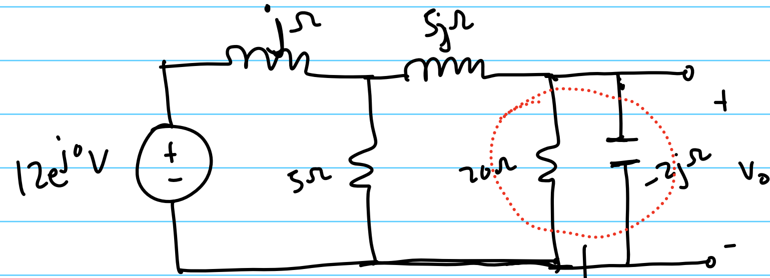
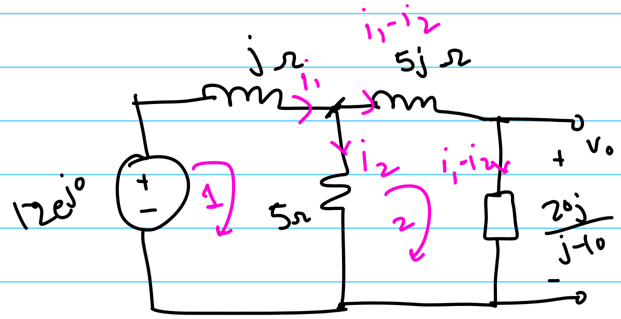
Ans.1



$$\frac{20 \times -2j}{20-2j} \Rightarrow \frac{-20j}{10-j} \Rightarrow \frac{20j}{j-10}$$



loop 1

$$+12 - i_1 j - i_2 5 = 0$$

$$5i_2 = -i_1 j + 12 \quad - (1)$$

loop 2

$$\cancel{5}i_2 - \cancel{5}j(i_1 - i_2) - (i_1 - i_2)\frac{\overset{4}{\cancel{20}}j}{j-10} = 0$$

$$i_2(j-10) - j(j-10)(i_1 - i_2) - 4j(i_1 - i_2) = 0$$

$$i_2 j - 10i_2 + (1+10j)(i_1 - i_2) - 4ji_1 + 4ji_2 = 0$$

$$ji_2 - 10i_2 + i_1 - i_2 + 10ji_1 - 10ji_2 - 4ji_1 + 4ji_2 = 0$$

$$-5ji_2 - 11i_2 + i_1 + 6ji_1 = 0$$

$$i_1(1+6j) - i_2(11+5j) = 0 \quad - ②$$

Substitute ① in ②

$$i_1(1+6j) + \frac{(ji_1 - 12)}{5}(11+5j) = 0$$

$$i_1 + 6ji_1 + \frac{1}{5}\left[11ji_1 - 5i_1 - 132 - 60j\right] = 0$$

$$\cancel{5}i_1 + 30ji_1 + 11ji_1 - \cancel{5i_1} - 132 - 60j = 0$$

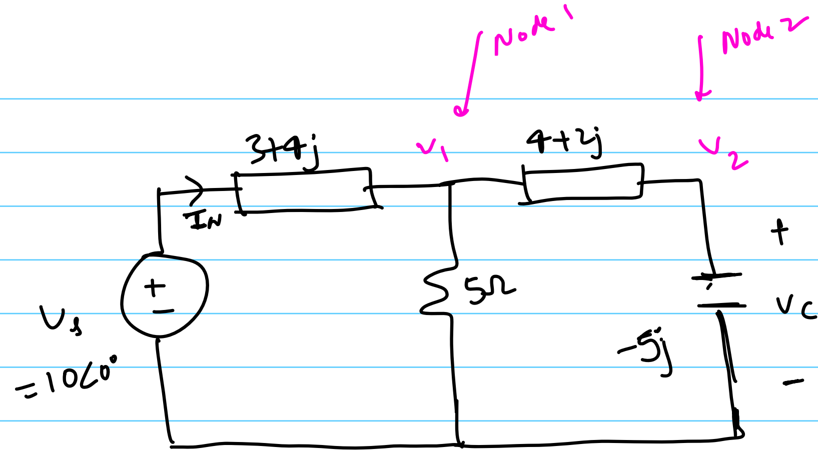
$$\boxed{i_1 \Rightarrow \frac{132+60j}{41j} \Rightarrow \frac{60}{41} - \frac{132}{41}j}$$

current delivered by the independent source.

$$i_2 = \frac{12 - ji_1}{5} \Rightarrow \frac{12 - j\left(\frac{60}{41} - \frac{132}{41}j\right)}{5} \Rightarrow \frac{72}{41} - \frac{12}{41}j$$

$$\boxed{V_o = (i_1 - i_2) \times \frac{20j}{j-10} \Rightarrow \frac{-240}{41}}$$

Ans.2



KCL @ Node 1

$$\frac{V_s - V_1}{3+4j} = \frac{V_1}{5} + \frac{V_1 - V_2}{(4+2j)}$$

$$V_s - V_1 = \frac{V_1}{5}(3+4j) + \frac{V_1 - V_2}{(4+2j)}(3+4j)$$

$$V_s - V_1 = V_1\left(\frac{3}{5} + \frac{4j}{5}\right) + (V_1 - V_2)\left(1 + \frac{i}{2}\right)$$

$$V_s = V_1\left(1 + \frac{3}{5} + 1 + \frac{4j}{5} + \frac{j}{2}\right) - V_2\left(1 + \frac{i}{2}\right)$$

$$10 = V_1\left(\frac{13}{5} + \frac{13}{10}j\right) - V_2\left(1 + \frac{j}{2}\right) \quad — \ 1$$

KCL @ Node 2

$$\frac{V_1 - V_2}{4+2j} = \frac{V_2}{-5j}$$

$$V_1 - V_2 = \frac{V_2}{-5j}(4+2j)$$

$$V_1 = V_2\left(\frac{3}{5}+\frac{4}{5}j\right) \quad — ②$$

Substitute ② in ①

$$10 = V_2\left(\frac{3}{5}+\frac{4}{5}j\right)\left(\frac{13}{5}+\frac{13}{10}j\right) - V_2\left(1+\frac{j}{2}\right)$$

$$10 = \left(\frac{-12}{25}+\frac{59}{25}j\right)V_2$$

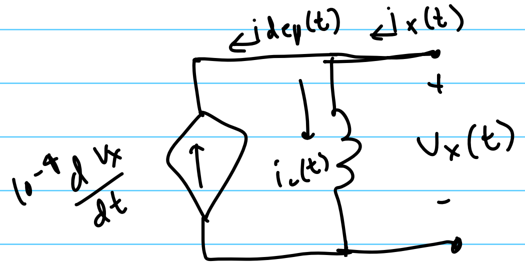
$$\boxed{V_2 \Rightarrow -\frac{24}{29} - \frac{118}{29}j} = V_c.$$

from ②

$$\boxed{V_1 = \frac{80}{29} - \frac{90}{29}j}$$

$$\boxed{I_N = \frac{V_s - V_1}{3+4j} \Rightarrow \frac{198}{145} - \frac{114}{145}j}$$

Ans.3



a) $\omega = 100 rad/s$, $L = 10H$

$V_x = V_0 \cos\omega t$

$$i_{dep}(t) = -10^{-4}\frac{dV_x}{dt} \Rightarrow V_0\omega \sin\omega t \times 10^{-4}$$

$$\Rightarrow -jV_0\omega\cos\omega t \times 10^{-4}$$

phasor domain equivalent,

$$i_{dep} \Rightarrow \underline{\underline{-j\, V_x \times (10^{-2})}}$$

$$\boxed{Z_{dep} = \frac{V_x}{i_{dep}} \Rightarrow \frac{j\,10^4}{\omega}}$$

b) $i_x = i_{dep} + i_L$

$$i_x \Rightarrow -j V_x \times 10^{-2} + \frac{V_x}{j \times 100 \times 10}$$

$$i_x = -j V_x 10^{-2} - j V_x 10^{-3}$$

$$i_x = -j V_x (10^{-2} + 10^{-3})$$

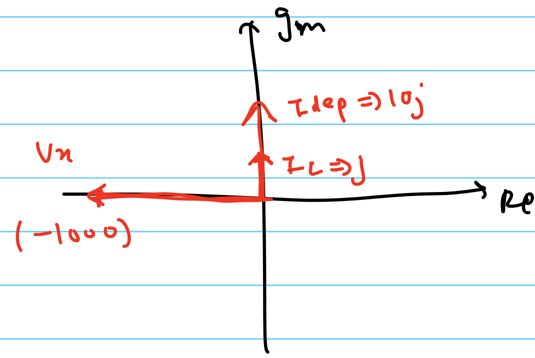
$$\frac{j}{10^{-2}+10^{-3}} = \frac{V_x}{i_x} = Z$$

$$\boxed{Z = \frac{1000}{11} j = 90.9 i}$$

c) $i_L = j$

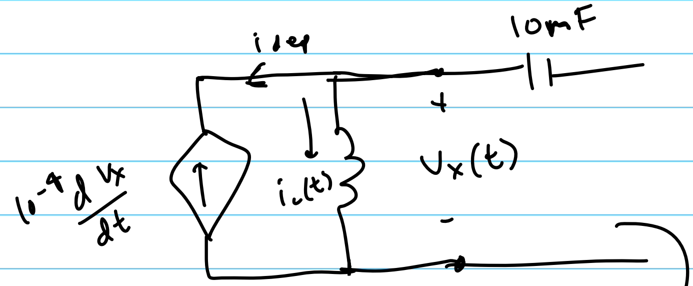
$$\frac{V_x}{j \times 100 \times 10} = j \Rightarrow \boxed{V_x = -1000}$$

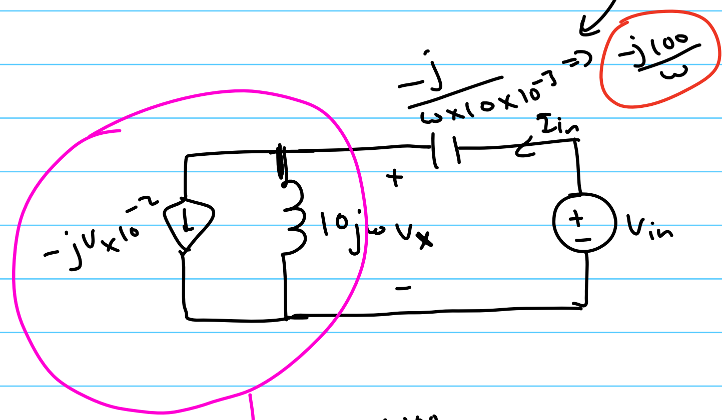
$$\boxed{i_{dep} \Rightarrow +10j}$$



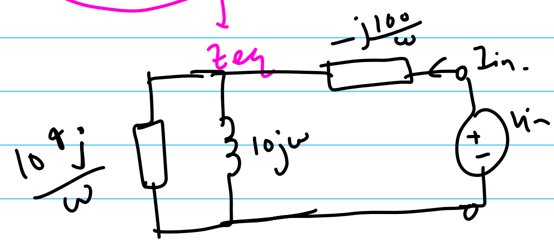
Ans.4

a)





$\frac{V_{in}}{I_{in}} = Z$



$$Z_{in} \Rightarrow \frac{-j100}{\omega} + \frac{\frac{10^4 j}{\omega} \times 10j\omega}{\frac{10^4 j}{\omega} + 10j\omega}$$

$$Z_{in} = \frac{-j100}{\omega} + \frac{-10^5\omega}{10^4 j + 10j\omega^2} \Rightarrow \frac{-j100}{\omega} + j\frac{10^5\omega}{(10^4 + 10\omega^2)}$$

$$Z_{in} = \frac{-j100}{\omega} + \frac{10^4 \omega j}{\omega^2 + 10^3}$$

b) Purely Resistive, $Im\{Z_{in}\} = 0$

$$-100(\omega^2+10^3)+10^4\omega^2=0$$

$$-(\omega^2+10^3)\ 1\ 0^2\omega^2=0$$

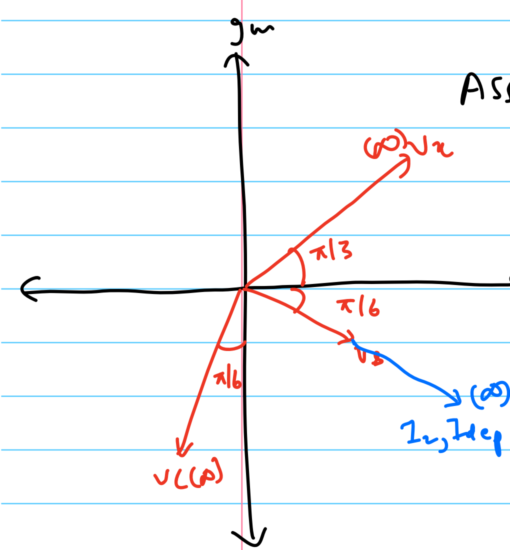
$$99\omega^2=1000$$

$$\omega=3.178 \Rightarrow \boxed{f=0.505Hz}$$

c) $V_x = 2\cos(\omega t-\pi/6)$

Real part = 0, @ Resonance, $\underline{\underline{i=\infty}}$.

$v_x, i_L, i_{dep}, v_o \rightarrow$ all tend to $\underline{\underline{\infty}}$.



Assuming resistance to be R, where $R\to 0$

$$I_{in} = \frac{2e^{-j\pi/6}}{R}$$

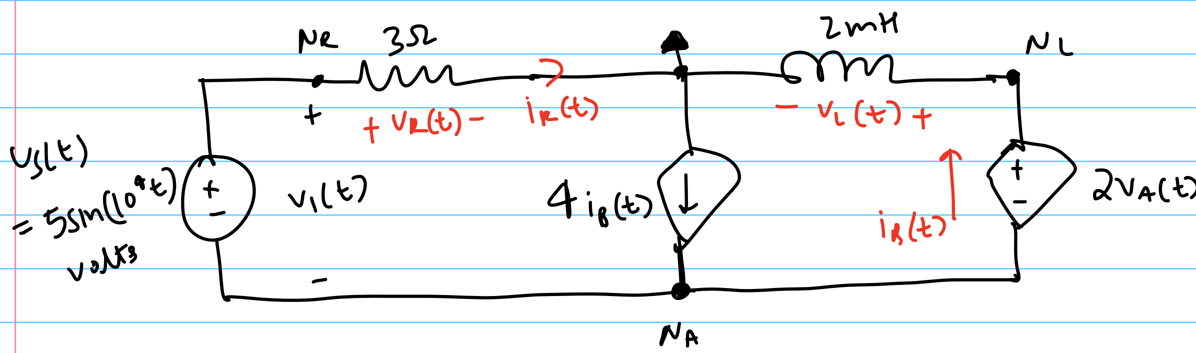
$$\underset{(R\to 0)}{I_L} = \frac{2e^{-j\pi/6}}{R} \times \frac{10^4 j/\omega}{10 j\omega + 10^4 j/\omega} \qquad \measuredangle I_L = -\pi/6$$

$$\underset{(R\to 0)}{I_{dep}} \Rightarrow \frac{2e^{-j\pi/6}}{R} \times \frac{10 j\omega}{10 j\omega + 10^4 j/\omega} \qquad \measuredangle I_{dep} = -\pi/6$$

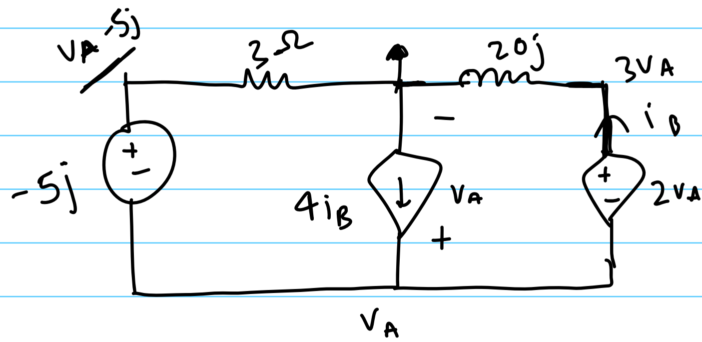
$$V_c \Rightarrow \frac{-j}{\omega}\times 100 \times \frac{2e^{-j\pi/6}}{R} \qquad \measuredangle V_C = -\frac{\pi}{2}-\frac{\pi}{6} \Rightarrow -\frac{2\pi}{3}$$

$$\measuredangle V_x \Rightarrow \frac{\pi}{2}-\frac{\pi}{6} \Rightarrow \frac{2\pi}{6} = \pi/3$$

Ans.5



a)



$$\frac{3V_A}{20j} \Rightarrow i_B$$

b)

$$\frac{V_A - 5j}{3} = 3 i_B$$

$$V_A - 5j \Rightarrow 9 \times \frac{3V_A}{20j}$$

$$V_A + \frac{27}{20} j V_A = 5j$$

$$V_A \left(1 + \frac{27}{20} j \right) = 5j$$

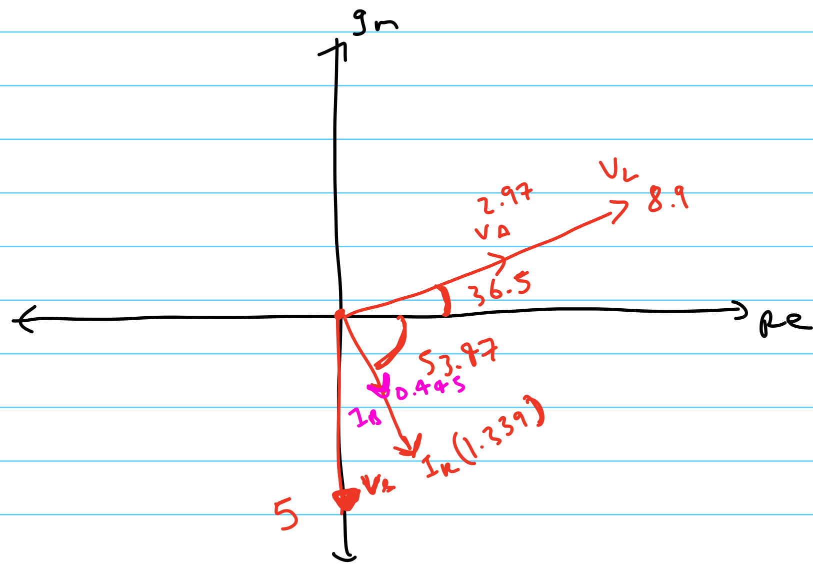
$$\boxed{V_A \Rightarrow \frac{5j}{1 + \frac{27}{20} j} \Rightarrow \underline{\underline{2.391 + 1.77j}}} \Rightarrow 2.97\angle 36.5$$

$$\boxed{i_B \Rightarrow 0.265 - 0.358j} \Rightarrow 0.445\angle{-53.49}$$

$$\boxed{I_R \Rightarrow \frac{V_A - 5j}{3} \Rightarrow 0.797 - 1.076j} \Rightarrow 1.339\angle{-53.47}$$

$$\boxed{V_L = i_B \times 20j \Rightarrow 7.16 + 5.3j} \Rightarrow 8.9\angle 36.5$$

c)

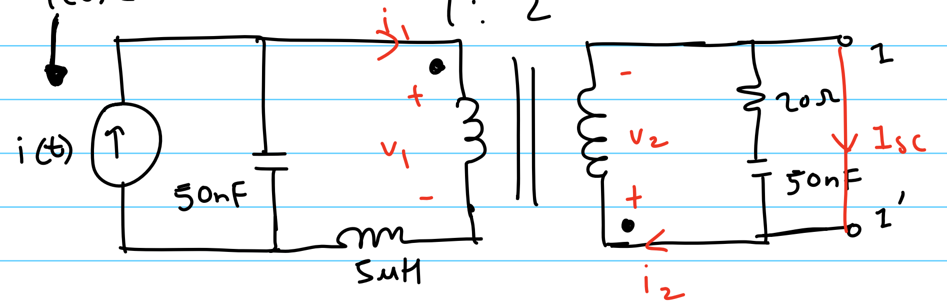


d) $V_A \Rightarrow 2.97\cos(10^4 t + 36.5)$

V_A leads V_s by $90 + 36.5 \Rightarrow \underline{\underline{126.5^\circ}}$

Ans.6

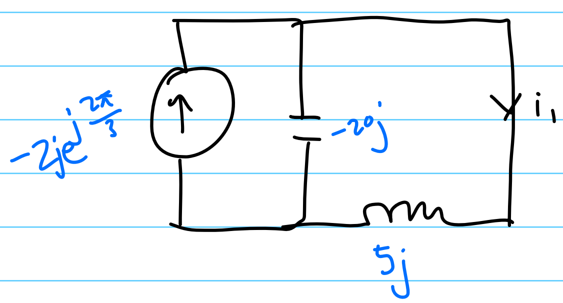
$i(t) = 2\sin(10^6 t + 120^\circ)$



$I_{sc} = i_2$

$V_2 = 2v_1 = 0$

$i_2 = -\frac{i_1}{2}$

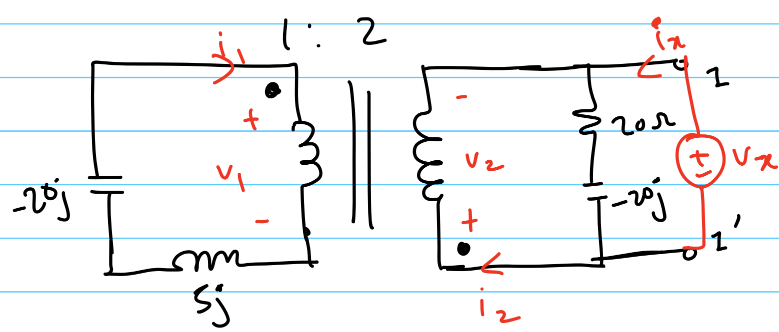


$i_1 = \frac{-20j}{-20j + 5j} \times -2e^{j2\pi/3} \times j$

$i_1 = -\frac{4}{3} \times 2e^{j2\pi/3} \times j$

$i_2 = \frac{2}{3} \times 2e^{j2\pi/3} \times j \Rightarrow \frac{4j}{3} e^{j2\pi/3}$

$$\boxed{I_{sc}(t) \Rightarrow \frac{4}{3}\cos\left(10^6 t + \frac{7\pi}{6}\right)}$$



$V_2 = 2v_1 = -v_x$

$i_2 = -\frac{i_1}{2}$

$$v_1 = -i_1(-15j) \Rightarrow 15 i_1 j$$

$$v_2 = 30 i_1 j = -60 i_2 j$$

$$-i_2 \Rightarrow \frac{v_2}{60j}$$

$$i_x \Rightarrow \frac{v_x}{20-20j} + \frac{v_2}{60j}$$

$$i_x \Rightarrow \frac{1}{20}\left[\frac{v_x}{1-j} - \frac{v_x}{3j}\right]$$

$$i_x \Rightarrow \frac{1}{20}\left[\frac{v_x 3j - v_x(1-j)}{(1-j)\,3j}\right.$$

$$\frac{20(3j)(1-j)}{3j-(1-j)} \Rightarrow \frac{v_x}{i_x} = Z_{TH}$$

$$\frac{60(j+1)}{4j-1} = Z_{TH} = \frac{180}{17} - \frac{300}{17}j$$