P 9.25 **[a]** $j\omega L = R\|(-j/\omega C) = j\omega L + \dfrac{-jR/\omega C}{R - j/\omega C}$

$$j\omega L + \frac{-jR}{\omega CR - j}$$

$$j\omega L + \frac{-jR(\omega CR + j)}{\omega^2C^2R^2 + 1}$$

$$\mathbf{Im}(Z_{\text{ab}}) = \omega L - \frac{\omega CR^2}{\omega^2C^2R^2 + 1} = 0$$

$$\therefore \qquad L = \frac{CR^2}{\omega^2C^2R^2 + 1}$$

$$\therefore \qquad \omega^2C^2R^2 + 1 = \frac{CR^2}{L}$$

$$\therefore \qquad \omega^2 = \frac{(CR^2/L) - 1}{C^2R^2} = \frac{\frac{(25\times10^{-9})(100)^2}{160\times10^{-6}} - 1}{(25\times10^{-9})^2(100)^2} = 900\times10^8$$

$$\omega = 300\,\text{krad/s}$$

[b] $Z_{\text{ab}}(300\times10^3) = j48 + \dfrac{(100)(-j133.33)}{100 - j133.33} = 64\,\Omega$

P 9.27 $Z_{\mathrm{ab}} = 1 - j8 + (2 + j4)\|(10 - j20) + (40\|j20)$

$$= 1 - j8 + 3 + j4 + 8 + j16 = 12 + j12\,\Omega = 16.97\underline{/45^\circ}\,\Omega$$

P 9.39 **[a]** $Z_{\text{eq}} = \frac{50{,}000}{3} + \frac{-j20\times10^6}{\omega}\|(1200 + j0.2\omega)$

$$= \frac{50{,}000}{3} + \frac{-j20\times10^6}{\omega}\,\frac{(1200+j0.2\omega)}{1200 + j[0.2\omega - \frac{20\times10^6}{\omega}]}$$

$$= \frac{50{,}000}{3} + \frac{\frac{-j20\times10^6}{\omega}(1200+j0.2\omega)\left[1200 - j\left(0.2\omega - \frac{20\times10^6}{\omega}\right)\right]}{1200^2 + \left(0.2\omega - \frac{20\times10^6}{\omega}\right)^2}$$

$$\mathbf{Im}(Z_{\text{eq}}) = -\frac{20\times10^6}{\omega}(1200)^2 - \frac{20\times10^6}{\omega}\left[0.2\omega\left(0.2\omega - \frac{20\times10^6}{\omega}\right)\right] = 0$$

$$-20\times10^6(1200)^2 - 20\times10^6\left[0.2\omega\left(0.2\omega - \frac{20\times10^6}{\omega}\right)\right] = 0$$

$$-(1200)^2 = 0.2\omega\left(0.2\omega - \frac{20\times10^6}{\omega}\right)$$

$$0.2^2\omega^2 - 0.2(20\times10^6) - 1200^2 = 0$$

$$\omega^2 = 64\times10^6 \qquad \therefore \qquad \omega = 8000\,\text{rad/s}$$

$$\therefore \qquad f = 1273.24\ \text{Hz}$$

[b] $Z_{\text{eq}} = \frac{50{,}000}{3} + -j2500\|(1200 + j1600)$

$$= \frac{50{,}000}{3} + \frac{(-j2500)(1200+j1600)}{1200 - j900} = 20{,}000\,\Omega$$

$$\mathbf{I}_g = \frac{30\underline{/0^\circ}}{20{,}000} = 1.5\underline{/0^\circ}\,\text{mA}$$

$$i_g(t) = 1.5\cos 8000t\,\text{mA}$$

P 9.45 Step 1 to Step 2:

$$\frac{240\underline{/0^\circ}}{j12} = -j20 = 20\underline{/-90^\circ}\text{ A}$$

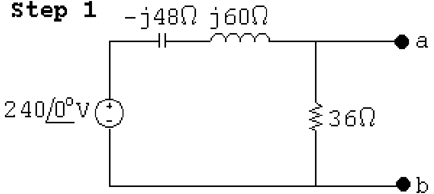
Step 2 to Step 3:

$$(j12)\|36 = 3.6 + j10.8\,\Omega$$

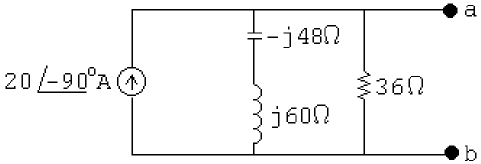
Step 3 to Step 4:

$$(20\underline{/-90^\circ})(3.6 + j10.8) = 216 - j72 = 227.68\underline{/-18.43^\circ}\text{ V}$$

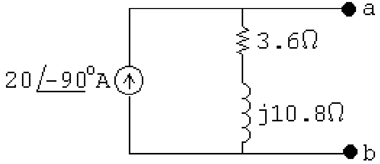
Step 1



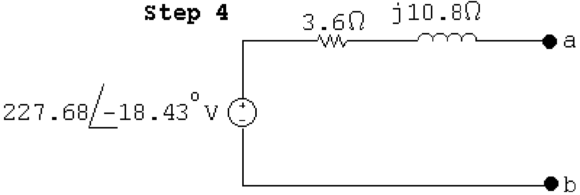
Step 2



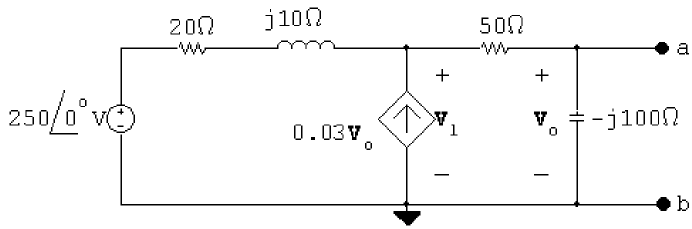
Step 3



Step 4



P 9.48 Open circuit voltage:



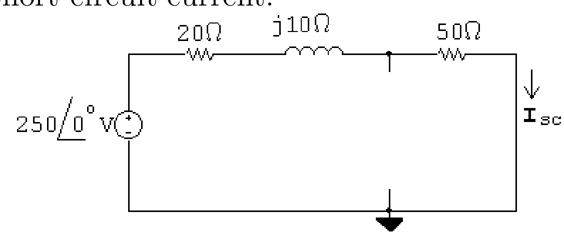
$$\frac{\mathbf{V}_1 - 250}{20 + j10} - 0.03\mathbf{V}_o + \frac{\mathbf{V}_1}{50 - j100} = 0$$

$$\therefore \quad \mathbf{V}_o = \frac{-j100}{50 - j100}\mathbf{V}_1$$

$$\frac{\mathbf{V}_1}{20 + j10} + \frac{j3\mathbf{V}_1}{50 - j100} + \frac{\mathbf{V}_1}{50 - j100} = \frac{250}{20 + j10}$$

$$\mathbf{V}_1 = 500 - j250\,\text{V}; \qquad \mathbf{V}_o = 300 - j400\,\text{V} = \mathbf{V}_{\text{Th}}$$

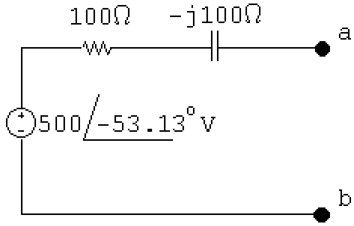
Short circuit current:



$$\mathbf{I}_{\text{sc}} = \frac{250/0^\circ}{70 + j10} = 3.5 - j0.5\,\text{A}$$

$$Z_{\text{Th}} = \frac{\mathbf{V}_{\text{Th}}}{\mathbf{I}_{\text{sc}}} = \frac{300 - j400}{3.5 - j0.5} = 100 - j100\,\Omega$$

The Thévenin equivalent circuit:



P 9.59 Write a KCL equation at the top node:

$$\frac{\mathbf{V}_o}{-j8} + \frac{\mathbf{V}_o - 2.4\mathbf{I}_\Delta}{j4} + \frac{\mathbf{V}_o}{5} - (10 + j10) = 0$$

The constraint equation is:

$$\mathbf{I}_\Delta = \frac{\mathbf{V}_o}{-j8}$$

Solving,

$$\mathbf{V}_o = j80 = 80\underline{/90^\circ}\,\mathrm{V}$$