Homework #7, Ch.9 EE 202
DUE DATE: May 13th, 2013

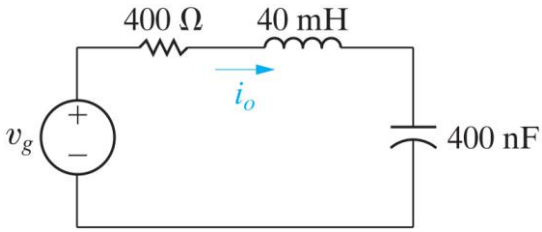
Problem #1

The circuit shown is operating in the sinusoidal steady state. Find the value of ω if

$$i_0 = 10\sin(\omega t + 111.87^0)\ \ mA$$

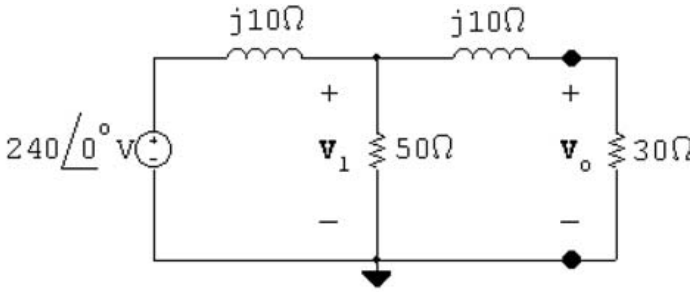
$$v_g = 5\cos(\omega t - 15^0)\ \ V$$

What is the phase difference between the voltage and current, take the voltage as reference.



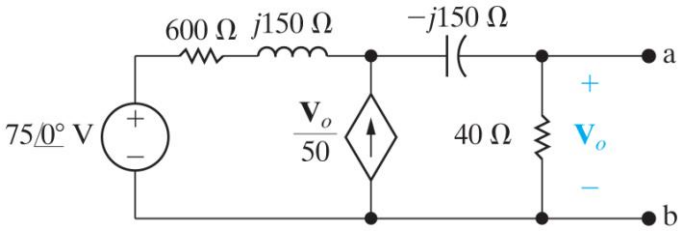
Problem #2

Find the voltages V_1 and V_0 of the circuit shown below:



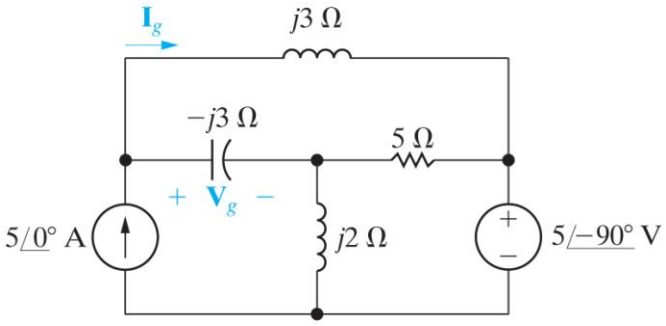
Problem #3

Find the Thevenin equivalent circuit with respect to the terminals a, b of the circuit shown below:



Problem #4

A) Use the node-voltage method (Check using Mesh Analysis) to find the phasor voltage $\mathbf{V_g}$ and phasor current $\mathbf{I_g}$.in the circuit shown below:



Problem 1

$I_g = 10\angle 51.8 - 90 = 10\angle -38.2^\circ \text{ mA}$

$V_g = 5\angle -15^\circ \text{ V}$

$Z = \frac{V_g}{I_g} = \frac{5}{10}\angle -15 + 38.2 = 0.5\angle 23.2^\circ \text{ k}\Omega$

$= 500\angle 23.2 = 459.6 + j\,197.0\ \Omega$

$Z = 459.6 + j\left(0.04\omega - \frac{2.5\times10^6}{\omega}\right)$

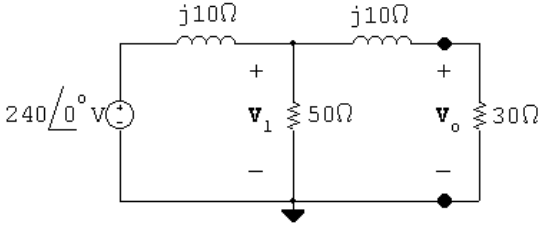
$\therefore\ 0.04\omega - \frac{2.5\times10^6}{\omega} = 197$

$4\omega^2 - 2.5\times10^8 - 1970\omega = 0$

$\omega^2 - 492.4\omega - 2.5\times10^8 = 0$

$\omega = \frac{4924 \pm \sqrt{492.4^2 + 2.5\times4\times10^8}}{2} \Rightarrow \omega = 18.4 \text{ Krad/s}$

$\therefore (\omega > 0)$

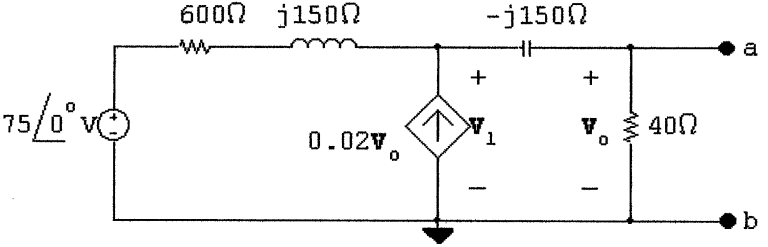


$$\frac{\mathbf{V}_1 - 240}{j10} + \frac{\mathbf{V}_1}{50} + \frac{\mathbf{V}_1}{30 + j10} = 0$$

Solving for $\mathbf{V}_1$ yields

$$\mathbf{V}_1 = 198.63\underline{/-24.44^\circ}\,\text{V}$$

$$\mathbf{V}_o = \frac{30}{30 + j10}(\mathbf{V}_1) = 188.43\underline{/-42.88^\circ}\,\text{V}$$



$$\frac{\mathbf{V}_1 - 75}{150(4+j1)} - \frac{0.02\mathbf{V}_1(40)}{40-j150} + \frac{\mathbf{V}_1}{40-j150} = 0$$

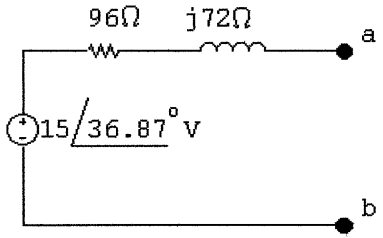
$$\therefore \quad \mathbf{V}_1 = \frac{75(4 - j15)}{16 - j12}$$

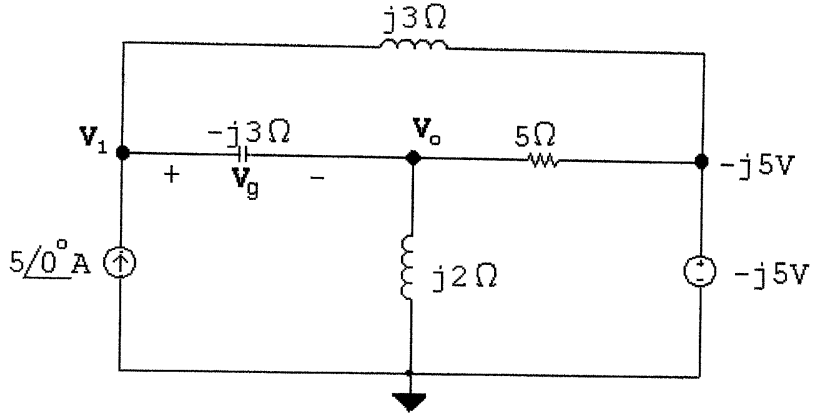
$$\mathbf{V}_{\text{Th}} = \frac{40\mathbf{V}_1}{40 - j150} = \frac{4}{4 - j15} \cdot \frac{75(4 - j15)}{16 - j12}$$

$$= \frac{75}{4 - j3} = 15\underline{/36.87^\circ}\ \text{V}$$

$$\mathbf{I}_{\text{sc}} = \frac{75}{600} = \frac{1}{8}\ \text{A}$$

$$Z_{\text{Th}} = \frac{\mathbf{V}_{\text{Th}}}{\mathbf{I}_{\text{sc}}} = 120\underline{/36.87^\circ} = 96 + j72\,\Omega$$





$$\frac{\mathbf{V}_o}{j2} + \frac{\mathbf{V}_o + j5}{5} + \frac{\mathbf{V}_o - \mathbf{V}_1}{-j3} = 0$$

$$(5 + j6)\mathbf{V}_o + 10\mathbf{V}_1 = 30$$

$$-5 + \frac{\mathbf{V}_1 - \mathbf{V}_o}{-j3} + \frac{\mathbf{V}_1 + j5}{j3} = 0$$

$$\mathbf{V}_o = j10; \qquad \mathbf{V}_1 = 9 - j5$$

$$\mathbf{V}_g = \mathbf{V}_1 - \mathbf{V}_o = 9 - j5 - j10 = 9 - j15 = 17.49\underline{/-59.04^\circ}\,\text{V}$$