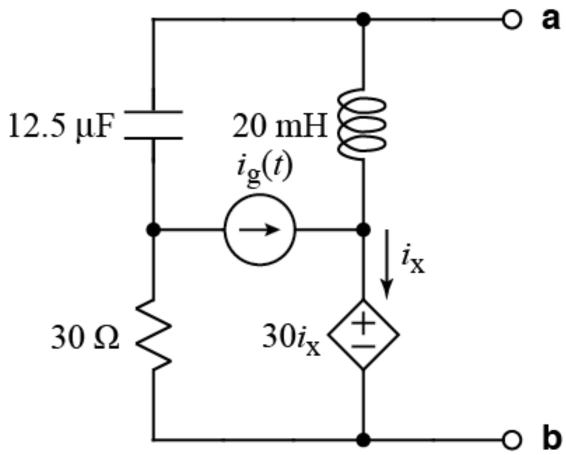
Ex:




$$i_g(t) = 20\cos(2\text{k}t)\ \text{A}$$

a) Draw a frequency-domain equivalent of the above circuit. Show a numerical phasor value for $i_g(t)$, and show numerical impedance values for $R$, $L$, and $C$. Label the dependent source appropriately.

b) Find the Thevenin equivalent (in the frequency domain) for the above circuit relative to terminals **a** and **b**. Give the numerical phasor value for $\mathbf{V}_{Th}$ and the numerical impedance value of $z_{Th}$.

**SOL'N:** a) The phasor for the current source is a real number (no phase shift).

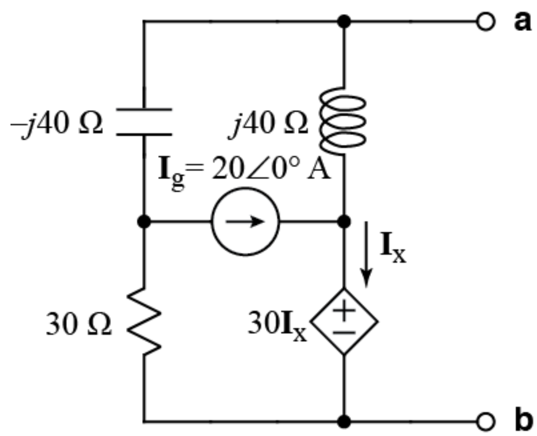
$$\mathbf{I}_g = 20\angle 0°\,\text{A}$$

From the expression for $i_g(t)$, we see that ω = 2 kr/s. We use this to calculate the impedance of the $L$ and $C$.

$$j\omega L = j2\text{k}(20\text{m})\ \Omega = j40\ \Omega$$

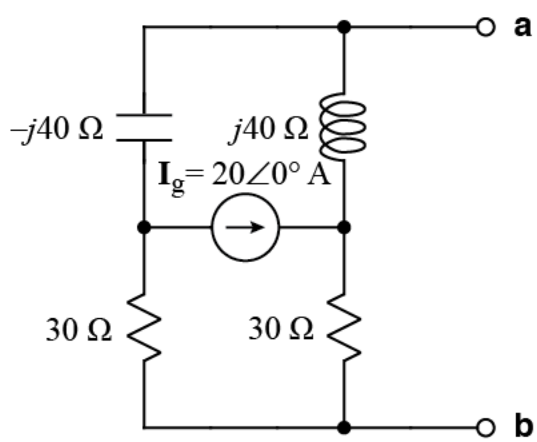
$$\frac{1}{j\omega C} = \frac{1}{j2\text{k}(12.5\mu)}\ \Omega = \frac{1}{j25\text{m}} = -j40\ \Omega$$

The dependent source just outputs 30 times the phasor $\mathbf{I}_x$.




b) We may replace the dependent source with a resistance since we have both the voltage and the current in terms of the current.

$$z_{eq} = \frac{30\mathbf{I}_x}{\mathbf{I}_x} = 30\ \Omega$$




The impedance in the top half of the circuit is 0 Ω. Consequently, all the current from the current source will flow in the top half of the circuit, and no current will flow around the bottom half.

The Thevenin equivalent voltage is $z_{ab}$. The voltage drop from **a** to **b** will be the voltage drop across the bottom right 30 Ω resistor, which is zero amps times 30 Ω, plus the voltage drop across the top right $j40$ Ω impedance, which is $-\mathbf{I}_x(j40\ \Omega)$.

$$\mathbf{V}_{Th} = \mathbf{V}_{ab} = -20\angle 0°\,\mathrm{A}\,(j40\,\Omega) = -j800\,\mathrm{V}$$

To find the Thevenin impedance, we turn off the current source, which becomes an open circuit, and look in from the **a** and **b** terminals. We see the left and right branches in parallel.

$$z_{\mathrm{Th}} = (30 - j40\,\Omega) \parallel (30 + j40\,\Omega)$$

or

$$z_{\mathrm{Th}} = \frac{1}{\dfrac{1}{30 - j40\,\Omega} + \dfrac{1}{30 + j40\,\Omega}}$$

or

$$z_{\mathrm{Th}} = \frac{1}{\dfrac{30 + j40}{30^2 + 40^2} + \dfrac{30 - j40}{30^2 + 40^2}}\ \Omega$$

or

$$z_{\mathrm{Th}} = \frac{1}{\dfrac{30 + j40}{50^2} + \dfrac{30 - j40}{50^2}}\ \Omega$$

or

$$z_{\mathrm{Th}} = \frac{50^2}{30 + j40 + 30 - j40}\ \Omega$$

or

$$z_{\mathrm{Th}} = \frac{2500}{60}\ \Omega = \frac{125}{3}\ \Omega \approx 41.67\,\Omega$$