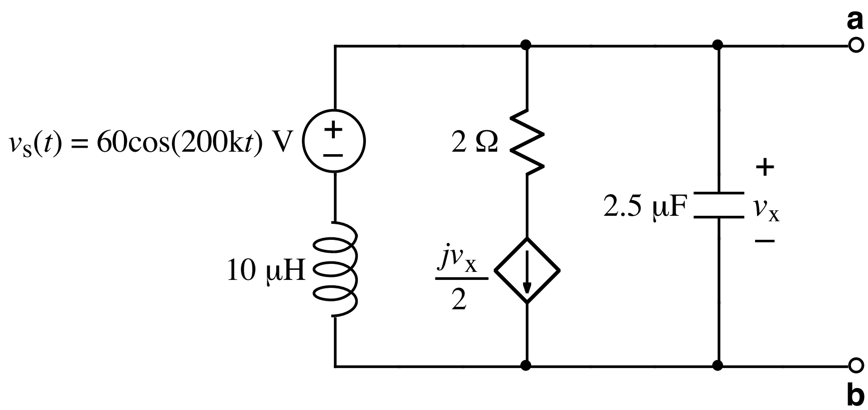
# HOMEWORK #16 solution probs 4 and 5

**Ex:**




a) Draw a frequency-domain equivalent of the above circuit. Show a numerical phasor value for $v_S(t)$, 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. Give the numerical phasor value for $\mathbf{V}_{Th}$ and the numerical impedance value of $z_{Th}$.

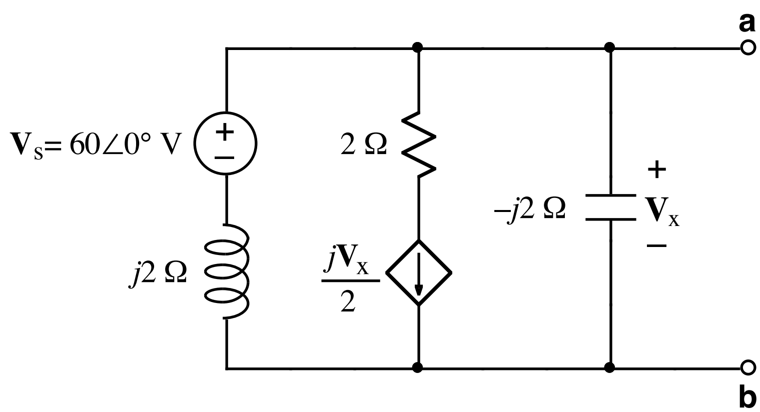
**SOL'N:** a) We calculate the impedances for the frequency-domain circuit:

$$\mathbf{V}_s = 60\angle 0° \text{ V}$$

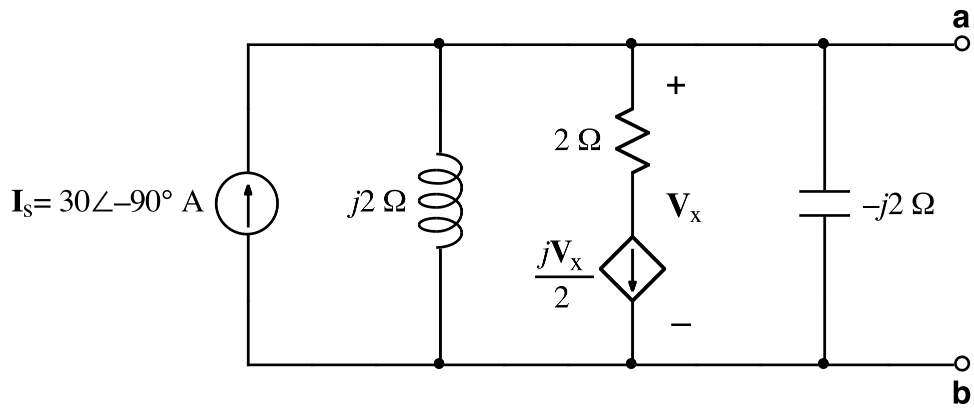
$$z_L = j\omega L = j200\text{k}\cdot 10\mu\ \Omega = j2\ \Omega$$

$$z_C = \frac{1}{j\omega C} = \frac{1}{j200\text{k}\cdot 2.5\mu}\ \Omega = -j2\ \Omega$$

The frequency domain circuit:



b) The Thevenin equivalent voltage is the voltage at **a** and **b** for the circuit with no load attached at **a** and **b**. We may perform a source transformation on the left side to obtain the following circuit:




In the above circuit, the inductance and capacitance in parallel are equivalent to an open circuit. With the inductor and capacitor gone, we see that current from $\mathbf{I}_S$ flows through the dependent current source. Thus, the dependent current source must have the same current as $\mathbf{I}_S$:

$$\frac{j\mathbf{V}_X}{2} = \mathbf{I}_S$$

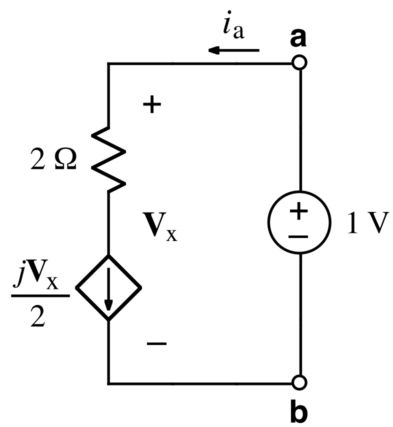
or

$$\mathbf{V}_X = \frac{2\mathbf{I}_S}{j} = \frac{2 \cdot 30\angle -90°\ \text{V}}{1\angle -90°} = 60\ \text{V}$$

This voltage is the same as the Thevenin equivalent voltage:

$$\mathbf{V}_{Th} = \mathbf{V}_X = 60\ \text{V}$$

To find the Thevenin impedance, we turn off the independent current (and remove the $L$ and $C$ that cancel out). Then we apply a voltage (1 V) to the **a** and **b** terminals:




We see that $\mathbf{V}_x = 1$ V and the dependent current source carries the current $i_a$:

$$i_a = \frac{j\mathbf{V}_x}{2} = j\frac{1}{2}\ \text{A}$$

The Thevenin impedance is 1 V divided by the current, $i_a$:

$$z_{Th} = \frac{1\ \text{V}}{i_a} = \frac{1\ \text{V}}{j\frac{1}{2}\ \text{A}} = -j2\ \Omega$$

Thus, we have the following Thevenin equivalent circuit: