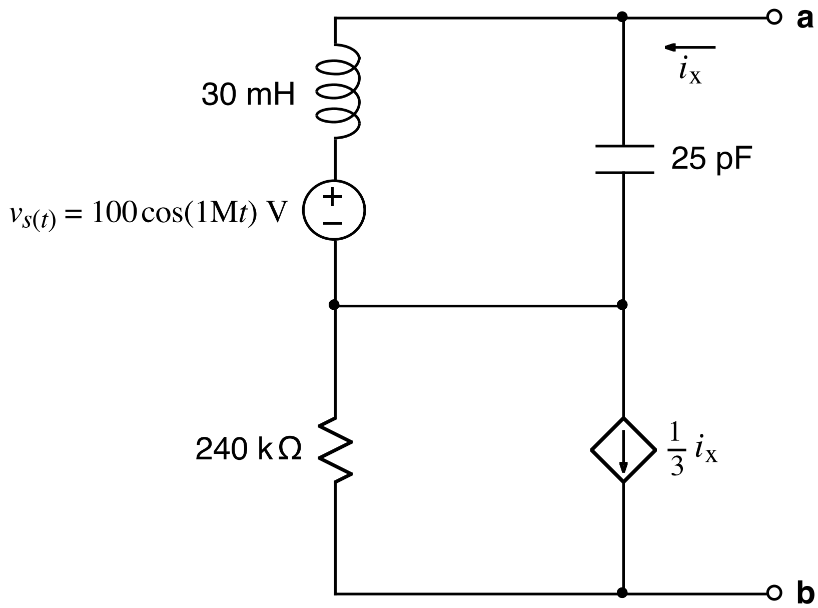
Ex:



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 V_{Th} and the numerical impedance value of z_{Th}.

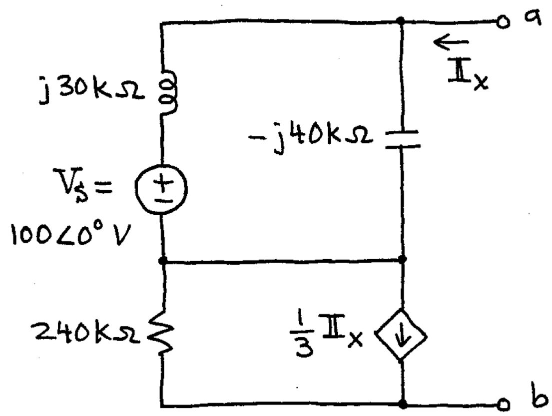
Sol'n: a) First, we find phasors and z values.

$$V_s = 100\angle 0°\text{ V} \qquad \omega = 1\text{M r/s}$$

$$z_L = j\omega L = j\,1\text{M r/s} \cdot 30\text{ mH} = j\,30\text{k}\Omega$$

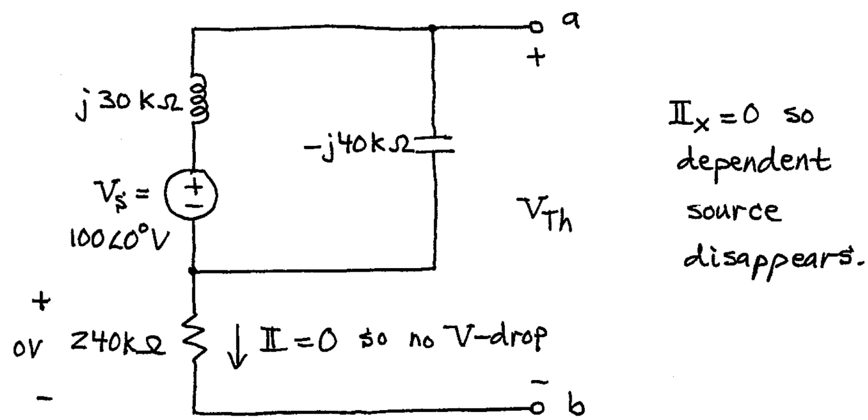
$$z_C = \frac{-j}{\omega C} = \frac{-j}{1\text{M r/s} \cdot 25\text{pF}} = \frac{-j\,\Omega}{25\mu} = -j40\text{k}\Omega$$

Now we can draw the frequency domain model:



b) We first find $V_{Th} = V_{a,b}$ with no load connected across a, b.

In this case, $I_x = 0$ A since a, b = open.



We have a V-divider:

$$V_{Th} = V_s \frac{-j40k\Omega}{-j40k\Omega + j30k\Omega} = V_s \frac{-j40k\Omega}{-j10k\Omega}$$

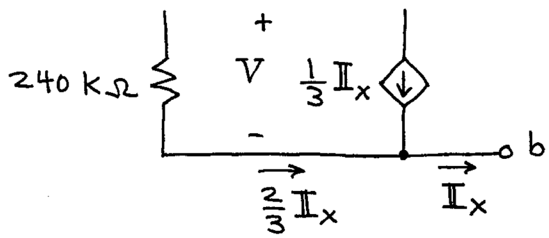
$$V_{Th} = 4V_s = 4(100\angle 0° V)$$

$$V_{Th} = 400\angle 0° V$$

To find z_{Th}, we replace the dependent source with an equivalent impedance.

We observe that, regardless of what is connected between **a** and **b**, I_x flows <u>out</u> of the **b** terminal, (and <u>into</u> the **a** terminal).

Consider a current summation at the bottom node:



We have current $\frac{2}{3}I_x$ through the 240kΩ.

The voltage across <u>both</u> the 240kΩ and the dependent source, by Ohm's law, will be $V = \frac{2}{3}I_x \cdot 240\,k\Omega$.

Thus, the equivalent impendance for the dependent source is found by using Ohm's law:

$$z_{eq} = \frac{V}{\frac{1}{3}I_x} = \frac{\frac{2}{3}\cancel{I_x}\cdot 240\,k\Omega}{\frac{1}{3}\cancel{I_x}}$$

$$= 2(240\,k\Omega)$$

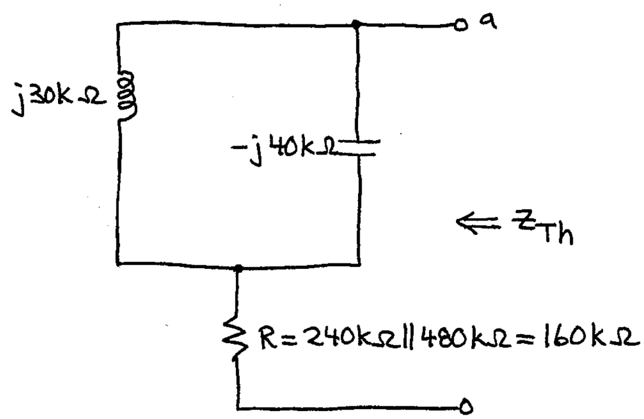
$$z_{eq} = 480\,k\Omega$$

Now we combine the 240kΩ and 480kΩ.

$$R = 240\text{ k}\Omega \| 480\text{ k}\Omega = 240\text{k}\Omega \cdot 1\|2$$

$$R = 240\text{k}\Omega \cdot \frac{2}{3} = 160\text{ k}\Omega$$

Finally, we turn off the V_s source and look into the circuit from the a, b terminals to find Z_{Th}:



$$Z_{Th} = j30\text{k}\Omega \| -j40\text{k}\Omega + 160\text{k}\Omega$$

$$= j10\text{k}\Omega \cdot 3\|-4 + 160\text{k}\Omega$$

$$= j10\text{k}\Omega \cdot \frac{-12}{-1} + 160\text{k}\Omega$$

$$= j120\text{k}\Omega + 160\text{k}\Omega$$

or $Z_{Th} = 160\text{k}\Omega + j120\text{ k}\Omega$