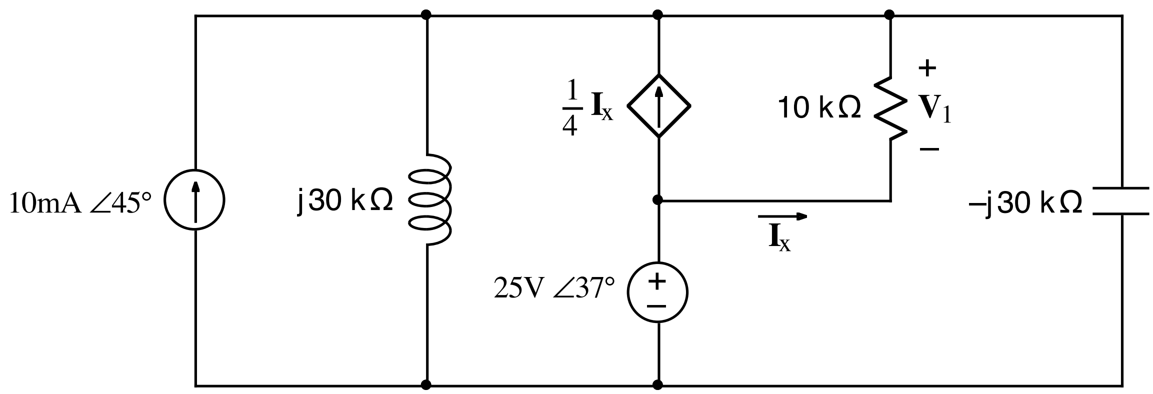
Ex:



a) A frequency-domain circuit is shown above. Write the value of phasor $\mathbf{V}_1$ in polar form.

b) Given $\omega = 25\text{k}$ rad/s, write a numerical time-domain expression for $v_1(t)$, the inverse phasor of $\mathbf{V}_1$.

Sol'n: a) First, we eliminate unnecessary components. The $j30\,k\Omega$ and $-j30\,k\Omega$ in parallel behave like an open circuit:

$$j30\,k\Omega \,\|\, -j30\,k\Omega = j30\,k\Omega \cdot 1 \| -1$$

$$= j30\,k\Omega \cdot \frac{-1}{0}$$

$$= -j\infty\,\Omega \quad \text{(open circuit)}$$

Second, we convert the dependent source to an equivalent impedance. The voltage across the dependent source equals $-V_1$ which equals minus $-\mathbb{I}_x \cdot 10\,k\Omega$.

$$V_1 = -\,\mathbb{I}_x \cdot 10\,k\Omega$$

Thus, $$z_{eq} = \frac{-V_1}{\frac{1}{4}\mathbb{I}_x} = \frac{\mathbb{I}_x \cdot 10\,k\Omega}{\frac{1}{4}\mathbb{I}_x} = 40\,k\Omega.$$

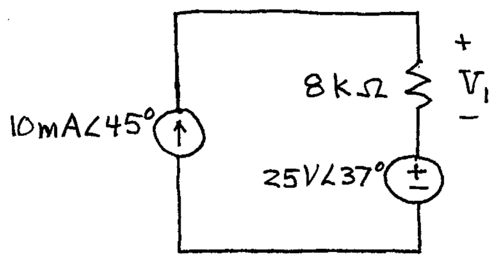
The R_{eq} in parallel with $10\,k\Omega$ gives

$$40\,k\Omega \parallel 10\,k\Omega = 10\,k\Omega \cdot 4 \parallel 1$$

$$= 10\,k\Omega \cdot \frac{4}{5}$$

$$= 8\,k\Omega$$

Our circuit model is now much simpler than before:



Now we see that the V source has no effect, as it is in series with a current source.

$$V_1 = 10\,mA \angle 45° \cdot 8\,k\Omega$$

$$V_1 = 80\,V \angle 45°$$

b) $v_1(t) = P^{-1}[V_1] = P^{-1}[80V \angle 45°]$ $\qquad \omega = 25k\ r/s$

$$v_1(t) = 80\cos(\omega t + 45°)V = 80\cos(25kt + 45°)V$$