Ex:

a) A frequency-domain circuit is shown above. Write the value of phasor current $I_1$ in polar form.

b) Given $\omega = 10$ rad/s, write a numerical time-domain expression for $i_1(t)$, the inverse phasor of $I_1$.

SOL’N: a) This circuit appears to be complicated but simplifies dramatically upon inspection. First, the $-j5 \, \Omega$ and $j5 \, \Omega$ resistors in series sum to zero and act like a wire. Second, that erstwhile wire bypasses the 5 kΩ resistor, meaning there is no voltage drop across the 5 kΩ resistor. This means we may ignore the 5 kΩ resistor. Third, the current $I_x$ must flow through the 3 kΩ and $j10I_x$ dependent source. But the current in the dependent source must be the same as $I_x$.

$$I_x = j10I_x$$

The only possible solution to this equation is $I_x = 0 \, A$. Thus, we have no current around the outside of the circuit, and we may ignore everything but the three components in the upper right-hand corner of the circuit.

Fourth, the $j6 \, \Omega$ inductance is directly across the voltage source, and we can calculate the current in the inductance.

$$i_L = \frac{12 \angle 90^\circ \, A}{j6 \, \Omega} = \frac{j12 \, A}{j6} = 2 \, A$$
Fifth, a current summation out the top rail of the circuit must equal zero.

\[ j2A + 2A + I_1 = 0 \text{ A} \]

Solving for \( I_1 \), yields the following value in rectangular form:

\[ I_1 = -2 - j2 \text{ A} \]

Converting to polar form, we have the following answer:

\[ I_1 = 2\sqrt{2} \angle -135^\circ \text{ A} \]

b) Using the value of \( \omega = 10 \text{ r/s} \), the value of \( i_1(t) \) is found:

\[ i_1(t) = 2\sqrt{2} \cos(10t - 135^\circ) \text{ A.} \]