1. Use mesh analysis to solve for I_0

$10\angle0°A$

$-j2$

8Ω 6Ω $j4$ $50\angle30°V$
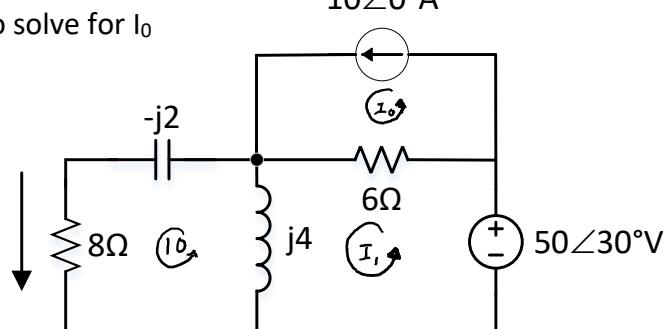
KVL I_0: $-j2\,I_0 + 8\,I_0 + j4(I_0 - I_1) = 0 \Rightarrow I_0(8+j2) + I_1(-j4) = 0$

KVL I_1: $-50\angle30° + 6(I_1 - 10) + j4(I_1 - I_0) = 0 \Rightarrow I_0(-j4) + I_1(6+4) = 60 + 50\angle30°$

$= 103.3 + j25$

$$\begin{bmatrix} 8+j2 & -j4 \\ -j4 & 6+j4 \end{bmatrix}\begin{bmatrix} I_0 \\ I_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 103.3+j25 \end{bmatrix} \Rightarrow \begin{bmatrix} I_0 \\ I_1 \end{bmatrix} = \begin{bmatrix} 5.97\angle65.4° \\ 12.3\angle-10.5 \end{bmatrix} \Rightarrow \boxed{I_0 = 5.97\angle65.4°A}$$

2. Challenging!

Find I_0 in the circuit below. Will need a supermesh.

Hint: where will the supermesh go? Write it in terms of I_1.

I_0

10Ω

$60\angle0°V$

$-j4$ $j8$

5 $-j6$
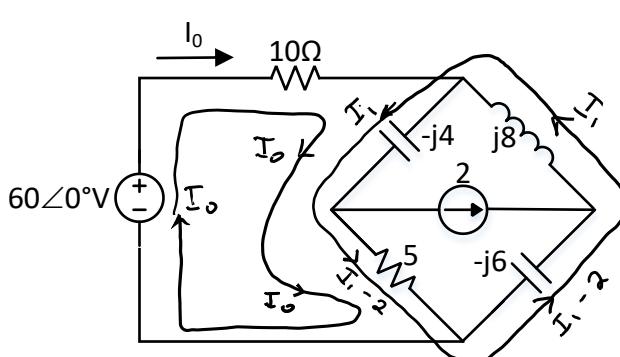
Left loop (starting le ft)
$-60 + 10 I_0 + (I_0 + I_1)(-j4) + (I_0 + I_1 - 2)5 = 0$
$I_0(10 - j4 + 5) + I_1(-j4 + 5) = 60 + 10$

Diamond loop (starting at right)
$I_1 j8 + (I_0 + I_1)(-j4) + (I_0 + I_1 - 2)5 + (I_1 - 2)(-j6) = 0$
$I_0(-j4 + 5) + I_1(j8 - j4 + 5 - j6) = 10 \cdot j12$

$$\begin{bmatrix} 15-j4 & 5-j4 \\ 5-j4 & 5-j2 \end{bmatrix}\begin{bmatrix} I_0 \\ I_1 \end{bmatrix} = \begin{bmatrix} 70 \\ 10-j12 \end{bmatrix} \Rightarrow \begin{bmatrix} I_0 \\ I_1 \end{bmatrix} = \begin{bmatrix} 5.95\angle3.2° \\ 4.34\angle176° \end{bmatrix}$$

$$\Rightarrow \boxed{I_0 = 5.95\angle3.2°A}$$