1. For the circuit in Fig. 1, find V_o.

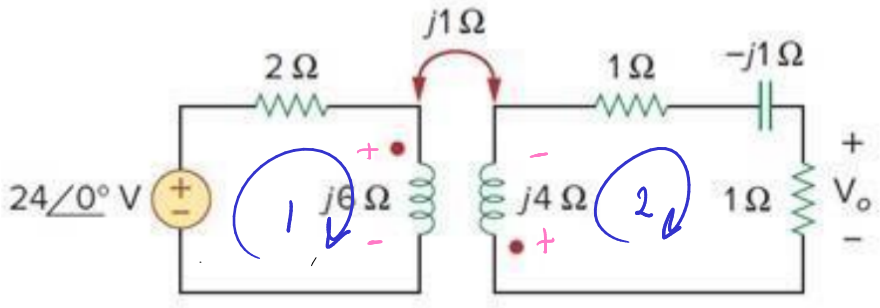


Figure 1

$$2I_1 + 6jI_1 + jI_2 = 24$$
$$I_1(2+6j) + I_2(j) = 24 \quad (1)$$

$$4jI_2 + I_2 - jI_2 + I_2 + jI_1 = 0$$
$$I_1(j) + I_2(3j+2) = 0 \quad (2)$$

$$I_1 = -I_2\frac{(3j+2)}{j\cdot j}\cdot j = I_2(2j-3) \Rightarrow I_2(2j-3)(2+6j) + I_2(j) = 24$$

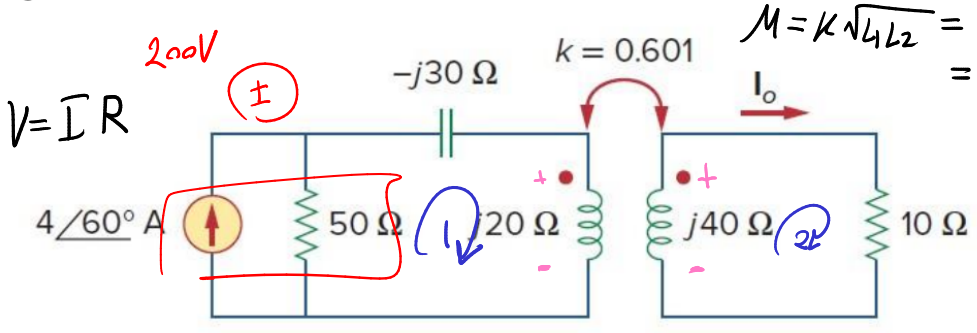
$$I_2(-18-13j) = 24$$

$$I_2 = -\frac{432}{493} + \frac{312}{493}j$$

$$= 1.080\angle 2.516$$

$$V_o = I_2 R = 1.080\angle 2.516$$

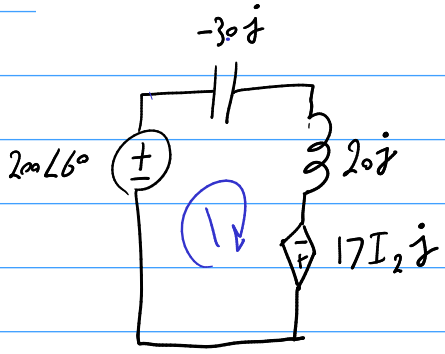
2. Find $\mathbf{I_o}$ in the circuit of Fig. 2. Switch the dot on the winding on the right and calculate $\mathbf{I_o}$ again.



$M = k\sqrt{L_1 L_2} = 0.601\sqrt{20 \times 40} = 17$

$V = IR$

Figure 2



$-30I_1 j + 20I_1 j - 17I_2 j = 200\angle 60$

$I_1(-10j) + I_2(-17j) = 200\angle 60$ (1)

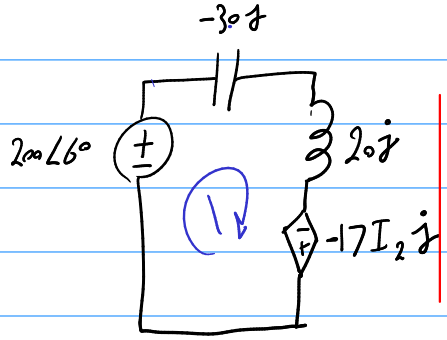
$I_2(10 + 40j) + I_1(-17j) = 0$

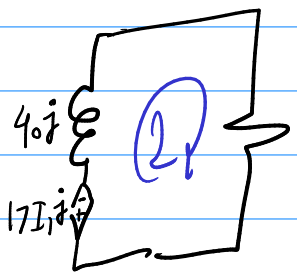
$I_2\left(40/17 - 10/17\, j\right)(-10j) + I_2(-17j) = 200\angle 60$

$I_1 = I_2 \dfrac{(10 + 40j)}{17j}$

$= I_2\left(\dfrac{40}{17} - \dfrac{10}{17}j\right)$

$\boxed{I_2 = 1.5\angle 92.03}$





$I_1(-30j + 20j) + I_2(17j) = 200\angle 60$

$I_2(10 + 40j) + I_1(17j) = 0$

$\Rightarrow I_2 = 1.5169\angle -87.96$

3. Determine currents $\mathbf{I_1}$, $\mathbf{I_2}$, *and* $\mathbf{I_3}$ in the circuit of Fig. 3. Find the energy stored in the coupled coils at $t = 2$ ms. Take $\omega = 1000$ rad/s. Repeat this problem with LTspice to verify your answer. Snapshot your circuit and the results.

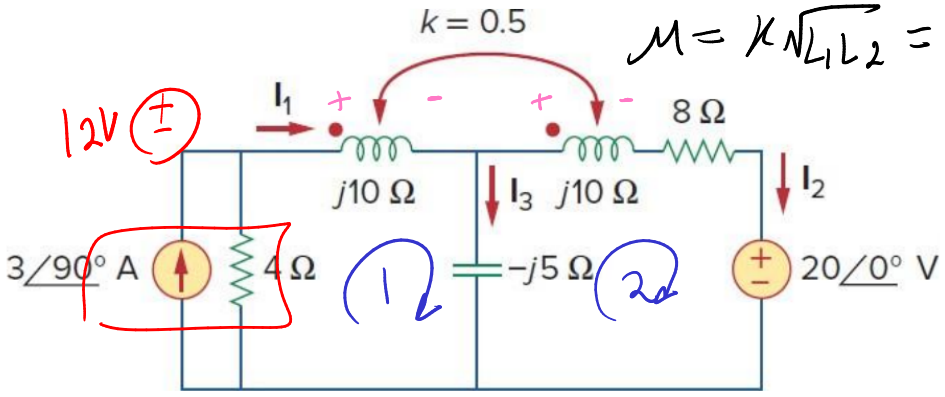


Figure 3

$M = k\sqrt{L_1 L_2} = 5$

$I_1(4+10j) + 5jI_2 - 5jI_3 = 12\angle 90$

$I_1(5j) + (8+10j)I_2 - 5jI_3 = -20\angle 0$

$I_1 = 0.763 + 2.343j = 2.461\angle 72.18^\circ$

$I_2 = -0.1142 - 0.8704j = 0.877\angle -97.5$

$I_3 = 0.8678 + 3.214j = 3.329\angle 74.89$

$\omega = 1000$

$\omega t = 1000 \times 2\text{ms} = 114.59^\circ$

$W = \sum_i^3 w_i = \sum_i^3 \frac{1}{2} V I_i^2 = \frac{1}{2} V \Sigma I = 0.0231$ J