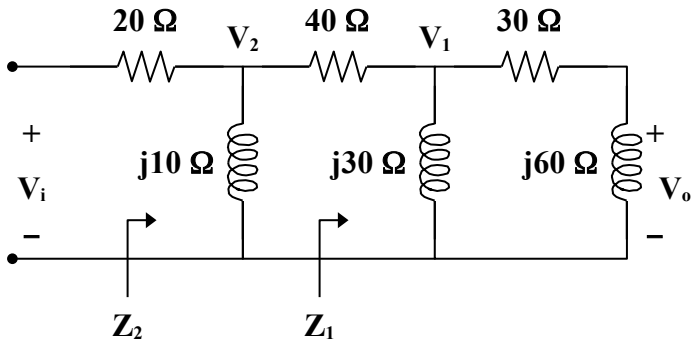
Chapter 9, Solution 79.

(a) Consider the circuit as shown.



$$\mathbf{Z}_1 = \text{j30} \,||\, (30 + \text{j60}) = \frac{(\text{j30})(30 + \text{j60})}{30 + \text{j90}} = 3 + \text{j21}$$

$$\mathbf{Z}_2 = \text{j10} \,||\, (40 + \mathbf{Z}_1) = \frac{(\text{j10})(43 + \text{j21})}{43 + \text{j31}} = 1.535 + \text{j8.896} = 9.028\angle 80.21^\circ$$

Let $\mathbf{V}_i = 1\angle 0^\circ$.

$$\mathbf{V}_2 = \frac{\mathbf{Z}_2}{\mathbf{Z}_2 + 20}\mathbf{V}_i = \frac{(9.028\angle 80.21^\circ)(1\angle 0^\circ)}{21.535 + \text{j8.896}}$$

$$\mathbf{V}_2 = 0.3875\angle 57.77^\circ$$

$$\mathbf{V}_1 = \frac{\mathbf{Z}_1}{\mathbf{Z}_1 + 40}\mathbf{V}_2 = \frac{3 + \text{j21}}{43 + \text{j21}}\mathbf{V}_2 = \frac{(21.213\angle 81.87^\circ)(0.3875\angle 57.77^\circ)}{47.85\angle 26.03^\circ}$$

$$\mathbf{V}_1 = 0.1718\angle 113.61^\circ$$

$$\mathbf{V}_o = \frac{\text{j60}}{30 + \text{j60}}\mathbf{V}_1 = \frac{\text{j2}}{1 + \text{j2}}\mathbf{V}_1 = \frac{2}{5}(2 + \text{j})\mathbf{V}_1$$

$$\mathbf{V}_o = (0.8944\angle 26.56^\circ)(0.1718\angle 113.6^\circ)$$

$$\mathbf{V}_o = 0.1536\angle 140.2^\circ$$

Therefore, the phase shift is **140.2°**

(b) The phase shift is **leading**.

(c) If $\mathbf{V}_i = 120$ V, then

$$\mathbf{V}_o = (120)(0.1536\angle 140.2^\circ) = 18.43\angle 140.2^\circ \text{ V}$$

and the magnitude is **18.43 V**.