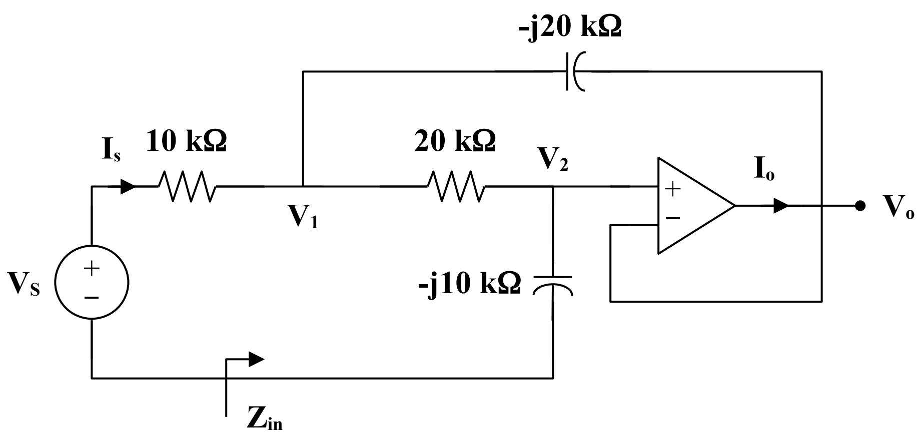
Chapter 10, Solution 73.

As a voltage follower, $\mathbf{V}_2 = \mathbf{V}_o$

$$C_1 = 10 \text{ nF} \longrightarrow \frac{1}{j\omega C_1} = \frac{1}{j(5\times10^3)(10\times10^{-9})} = \text{-j}20 \text{ k}\Omega$$

$$C_2 = 20 \text{ nF} \longrightarrow \frac{1}{j\omega C_2} = \frac{1}{j(5\times10^3)(20\times10^{-9})} = \text{-j}10 \text{ k}\Omega$$

Consider the circuit in the frequency domain as shown below.



At node 1,

$$\frac{\mathbf{V}_s - \mathbf{V}_1}{10} = \frac{\mathbf{V}_1 - \mathbf{V}_o}{\text{-}j20} + \frac{\mathbf{V}_1 - \mathbf{V}_o}{20}$$

$$2\,\mathbf{V}_s = (3+j)\mathbf{V}_1 - (1+j)\mathbf{V}_o \qquad (1)$$

At node 2,

$$\frac{\mathbf{V}_1 - \mathbf{V}_o}{20} = \frac{\mathbf{V}_o - 0}{\text{-}j10}$$

$$\mathbf{V}_1 = (1+j2)\mathbf{V}_o \qquad (2)$$

Substituting (2) into (1) gives

$$2\,\mathbf{V}_s = j6\mathbf{V}_o \quad \text{or} \quad \mathbf{V}_o = \text{-}j\frac{1}{3}\mathbf{V}_s$$

$$\mathbf{V}_1 = (1+j2)\mathbf{V}_o = \left(\frac{2}{3} - j\frac{1}{3}\right)\mathbf{V}_s$$

$$\mathbf{I}_s = \frac{\mathbf{V}_s - \mathbf{V}_1}{10k} = \frac{(1/3)(1+j)}{10k}\mathbf{V}_s$$

$$\frac{\mathbf{I}_s}{\mathbf{V}_s} = \frac{1+j}{30k}$$

$$\mathbf{Z}_{in} = \frac{\mathbf{V}_s}{\mathbf{I}_s} = \frac{30k}{1+j} = 15(1-j)\,k$$

$$\mathbf{Z}_{in} = \mathbf{21.21\angle{-45^\circ}\ k\Omega}$$