Chapter 9, Solution 77.

Refer to the *RC* circuit in Fig. 9.81.

(a) Calculate the phase shift at 2 MHz.

(b) Find the frequency where the phase shift is 45°.

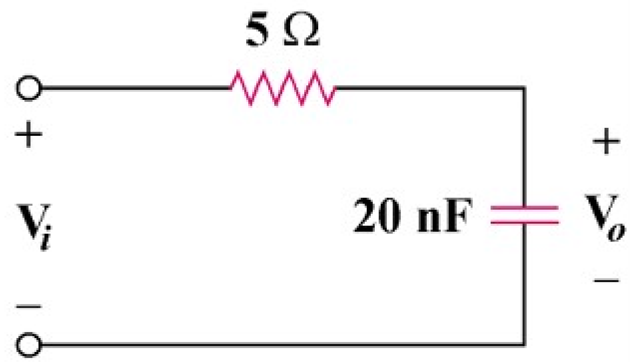

Figure 9.81
For Prob. 9.77.

Solution

(a)

$$\mathbf{V}_o = \frac{-jX_c}{R - jX_c}\mathbf{V}_i$$

where $X_c = \dfrac{1}{\omega C} = \dfrac{1}{(2\pi)(2\times 10^6)(20\times 10^{-9})} = 3.979$

$$\frac{\mathbf{V}_o}{\mathbf{V}_i} = \frac{-j3.979}{5 - j3.979} = \frac{3.979}{\sqrt{5^2 + 3.979^2}}\angle(-90° + \tan^{-1}(3.979/5))$$

$$\frac{\mathbf{V}_o}{\mathbf{V}_i} = \frac{3.979}{\sqrt{25 + 15.83}}\angle(-90° - 38.51°)$$

$$\frac{\mathbf{V}_o}{\mathbf{V}_i} = 0.6227\angle -51.49°$$

Therefore, the phase shift is **51.49° lagging**

(b)

$$\theta = -45° = -90° + \tan^{-1}(X_c/R)$$

$$45° = \tan^{-1}(X_c/R) \longrightarrow R = X_c = \frac{1}{\omega C}$$

$$\omega = 2\pi f = \frac{1}{RC}$$

$$f = \frac{1}{2\pi RC} = \frac{1}{(2\pi)(5)(20 \times 10^{-9})} = \textbf{1.5915 MHz}$$