

**Problem 1.25** A voltage source given by

$$v_s(t) = 25 \cos(2\pi \times 10^3 t - 30^\circ) \quad (\text{V})$$

is connected to a series RC load as shown in Fig. 1-20. If  $R = 1 \text{ M}\Omega$  and  $C = 200 \text{ pF}$ , obtain an expression for  $v_c(t)$ , the voltage across the capacitor.

**Solution:** In the phasor domain, the circuit is a voltage divider, and

$$\tilde{V}_c = \tilde{V}_s \frac{1/j\omega C}{R + 1/j\omega C} = \frac{\tilde{V}_s}{(1 + j\omega RC)}.$$

Now  $\tilde{V}_s = 25e^{-j30^\circ} \text{ V}$  with  $\omega = 2\pi \times 10^3 \text{ rad/s}$ , so

$$\begin{aligned} \tilde{V}_c &= \frac{25e^{-j30^\circ} \text{ V}}{1 + j((2\pi \times 10^3 \text{ rad/s}) \times (10^6 \Omega) \times (200 \times 10^{-12} \text{ F}))} \\ &= \frac{25e^{-j30^\circ} \text{ V}}{1 + j2\pi/5} = 15.57e^{-j81.5^\circ} \text{ V}. \end{aligned}$$

Converting back to an instantaneous value,

$$v_c(t) = \Re \tilde{V}_c e^{j\omega t} = \Re 15.57e^{j(\omega t - 81.5^\circ)} \text{ V} = 15.57 \cos(2\pi \times 10^3 t - 81.5^\circ) \text{ V},$$

where  $t$  is expressed in seconds.

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