EXAMPLE 15.1

Calculate the input power, output power, and efficiency of the amplifier circuit in Fig. 15.5 for an input voltage that results in a base current of 10 mA peak.

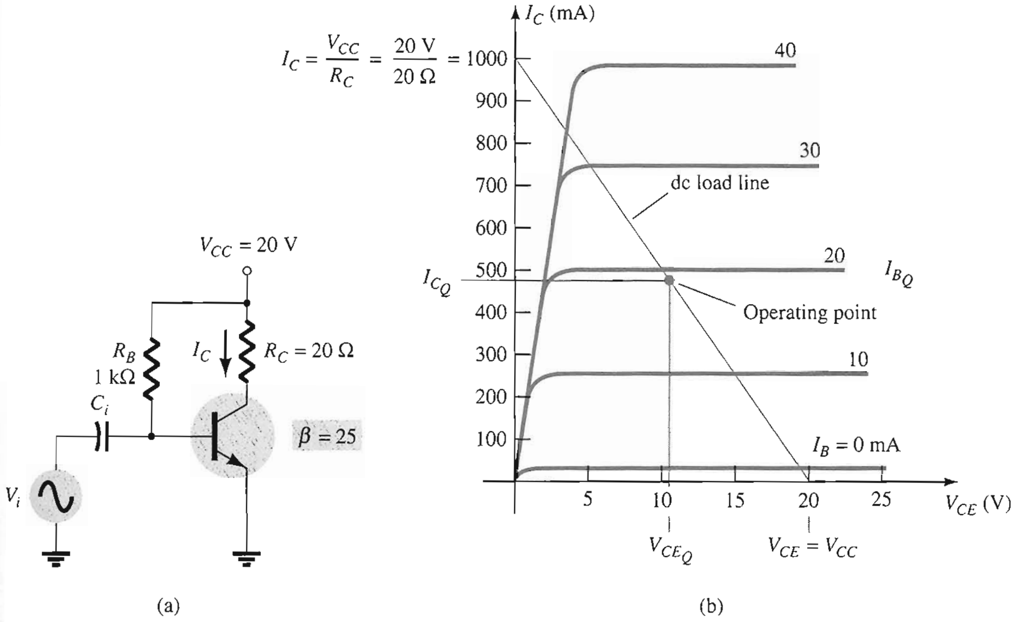

Figure 15.5 Operation of a series-fed circuit for Example 15.1.

Solution

Using Eqs. (15.1) through (15.3), the Q-point can be determined to be

$$I_{B_Q} = \frac{V_{CC} - 0.7\text{ V}}{R_B} = \frac{20\text{ V} - 0.7\text{ V}}{1\text{ k}\Omega} = 19.3\text{ mA}$$

$$I_{C_Q} = \beta I_B = 25(19.3\text{ mA}) = 482.5\text{ mA} \cong 0.48\text{ A}$$

$$V_{CE_Q} = V_{CC} - I_C R_C = 20\text{ V} - (0.48\ \Omega)(20\ \Omega) = 10.4\text{ V}$$

This bias point is marked on the transistor collector characteristic of Fig. 15.5b. The ac variation of the output signal can be obtained graphically using the dc load line drawn on Fig. 15.5b by connecting $V_{CE} = V_{CC} = 20$ V with $I_C = V_{CC}/R_C = 1000$ mA $= 1$ A, as shown. When the input ac base current increases from its dc bias level, the collector current rises by

$$I_C(\text{p}) = \beta I_B(\text{p}) = 25(10\text{ mA peak}) = 250\text{ mA peak}$$

Using Eq. (15.6b) yields

$$P_o(\text{ac}) = \frac{I_C^2(\text{p})}{2} R_C = \frac{(250 \times 10^{-3}\text{ A})^2}{2}(20\ \Omega) = \mathbf{0.625\ W}$$

Using Eq. (15.4) results in

$$P_i(\text{dc}) = V_{CC} I_{C_Q} = (20\text{ V})(0.48\text{ A}) = \mathbf{9.6\ W}$$

The amplifier's power efficiency can then be calculated using Eq. (15.8):

$$\%\,\eta = \frac{P_o(\text{ac})}{P_i(\text{dc})} \times 100\% = \frac{0.625\text{ W}}{9.6\text{ W}} \times 100\% = \mathbf{6.5\%}$$