For the ideal transformer, the voltage delivered to the load can be calculated using Eq. (15.9):

$$V_L = V_2 = \frac{N_2}{N_1} V_1$$

The power across the load can then be expressed as

$$P_L = \frac{V_L^2(\text{rms})}{R_L}$$

and equals the power calculated using Eq. (15.5c).

Using Eq. (15.10) to calculate the load current yields

$$I_L = I_2 = \frac{N_1}{N_2} I_C$$

with the output ac power then calculated using

$$P_L = I_L^2(\text{rms}) R_L$$

EXAMPLE 15.4

Calculate the ac power delivered to the 8-Ω speaker for the circuit of Fig. 15.10. The circuit component values result in a dc base current of 6 mA, and the input signal (V_i) results in a peak base current swing of 4 mA.

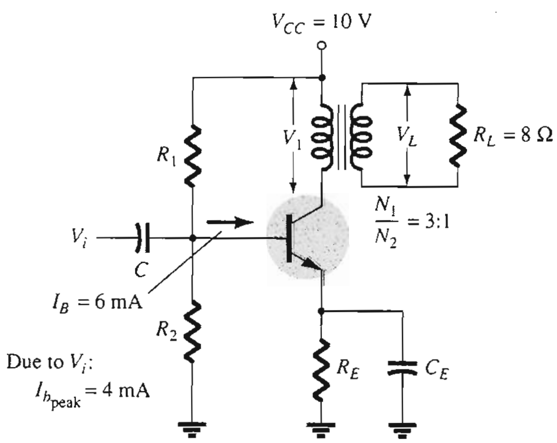

Figure 15.10 Transformer-coupled class A amplifier for Example 15.4.

Solution

The dc load line is drawn vertically (see Fig. 15.11) from the voltage point:

$$V_{CE_Q} = V_{CC} = 10 \text{ V}$$

For $I_B = 6$ mA, the operating point on Fig. 15.11 is

$$V_{CE_Q} = 10 \text{ V} \quad \text{and} \quad I_{C_Q} = 140 \text{ mA}$$

The effective ac resistance seen at the primary is

$$R'_L = \left(\frac{N_1}{N_2}\right)^2 R_L = (3)^2(8) = 72\ \Omega$$

The ac load line can then be drawn of slope $-1/72$ going through the indicated operating point. To help draw the load line, consider the following procedure. For a current swing of

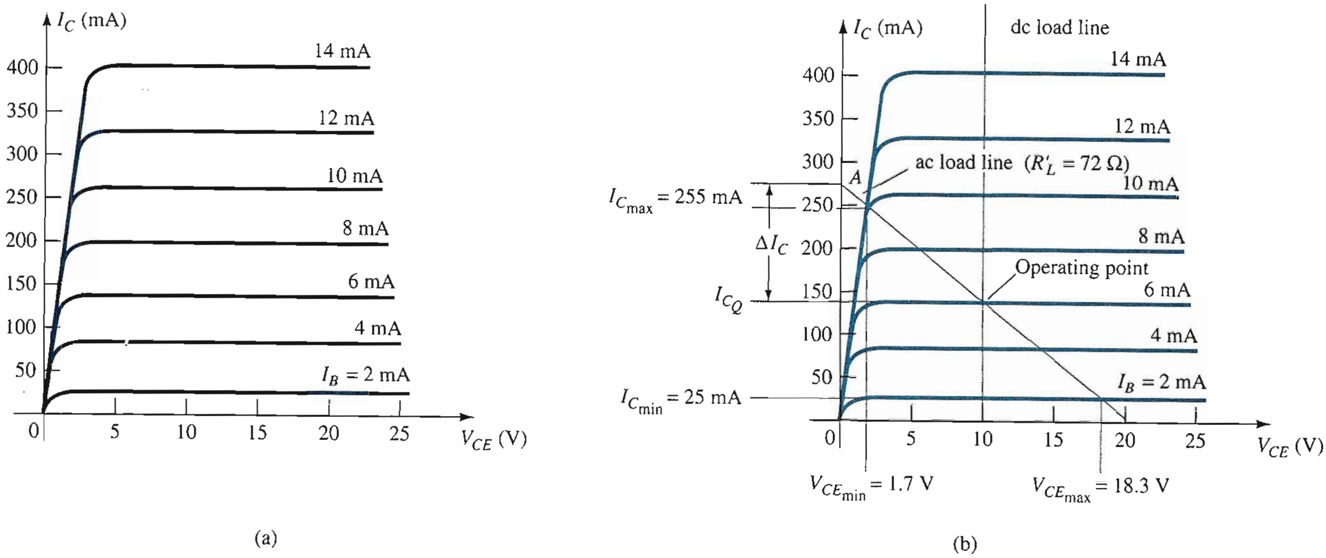

Figure 15.11 Transformer-coupled class A transistor characteristic for Examples 15.4 and 15.5: (a) device characteristic; (b) dc and ac load lines.

$$I_C = \frac{V_{CE}}{R'_L} = \frac{10\text{ V}}{72\ \Omega} = 139\text{ mA}$$

mark a point (*A*):

$$I_{CE_Q} + I_C = 140\text{ mA} + 139\text{ mA} = 279\text{ mA along the } y\text{-axis}$$

Connect point *A* through the *Q*-point to obtain the ac load line. For the given base current swing of 4 mA peak, the maximum and minimum collector current and collector–emitter voltage obtained from Fig. 15.11 are

$$V_{CE_{min}} = 1.7\text{ V} \qquad I_{C_{min}} = 25\text{ mA}$$

$$V_{CE_{max}} = 18.3\text{ V} \qquad I_{C_{max}} = 255\text{ mA}$$

The ac power delivered to the load can then be calculated using Eq. (15.13):

$$P_o(\text{ac}) = \frac{(V_{CE_{max}} - V_{CE_{min}})(I_{C_{max}} - I_{C_{min}})}{8}$$

$$= \frac{(18.3\text{ V} - 1.7\text{ V})(255\text{ mA} - 25\text{ mA})}{8} = \mathbf{0.477\ W}$$

Efficiency

So far we have considered calculating the ac power delivered to the load. We next consider the input power from the battery, power losses in the amplifier, and the overall power efficiency of the transformer-coupled class A amplifier.

The input (dc) power obtained from the supply is calculated from the supply dc voltage and the average power drawn from the supply:

$$\boxed{P_i(\text{dc}) = V_{CC} I_{C_Q}} \qquad (15.14)$$

For the transformer-coupled amplifier, the power dissipated by the transformer is small (due to the small dc resistance of a coil) and will be ignored in the present calcula-