Chapter.6

BJT Amplifiers

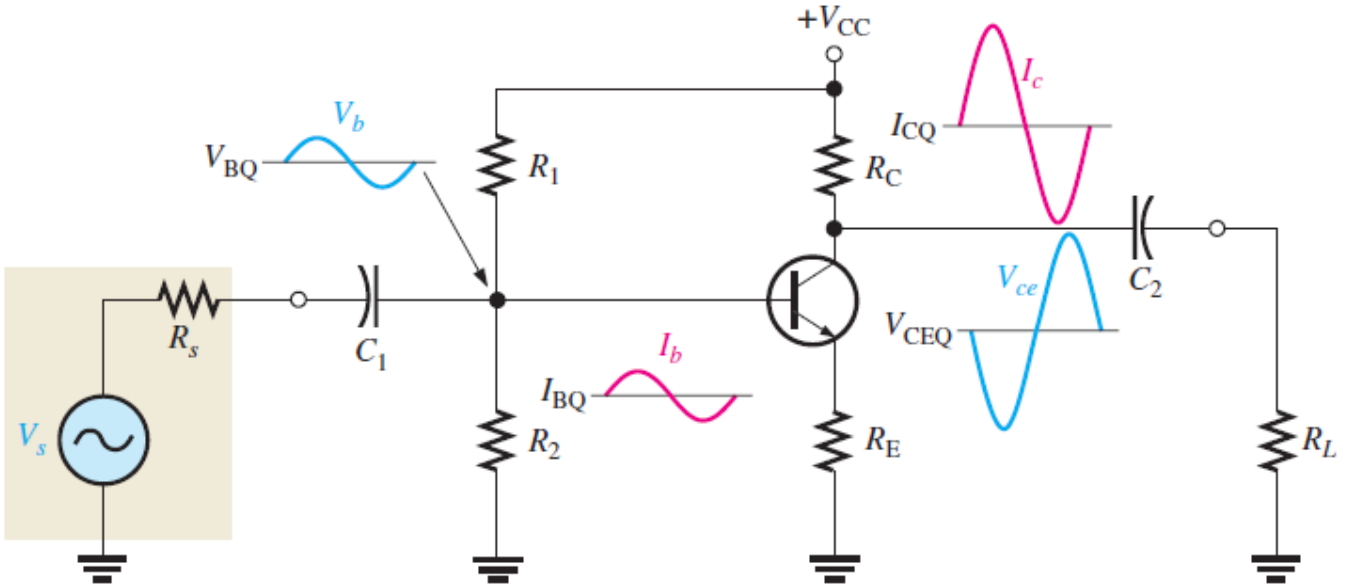


FIGURE 6–2

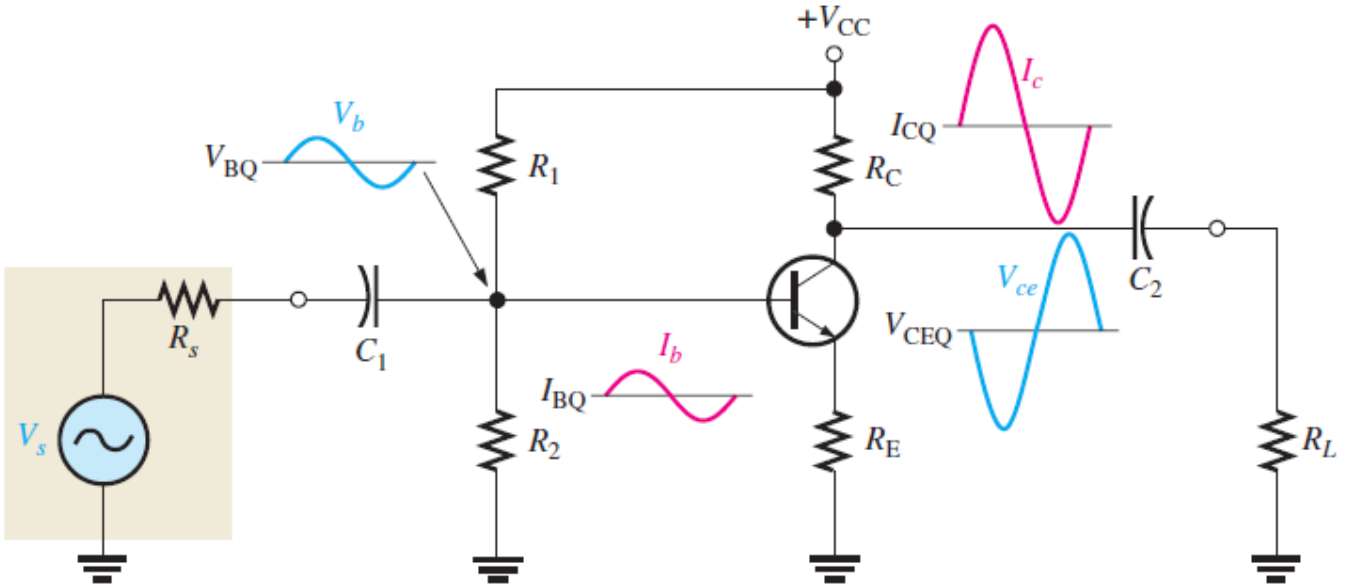
An amplifier with voltage-divider bias driven by an ac voltage source with an internal resistance, R_s.

Amplifier Operation

- The biasing of a transistor is purely a dc operation. The purpose of biasing is to establish a Q-point about which variations in current and voltage can occur in response to an ac input signal.

- In applications where small signal voltages must be amplified— such as from an antenna or a microphone—variations about the Q-point are relatively small.

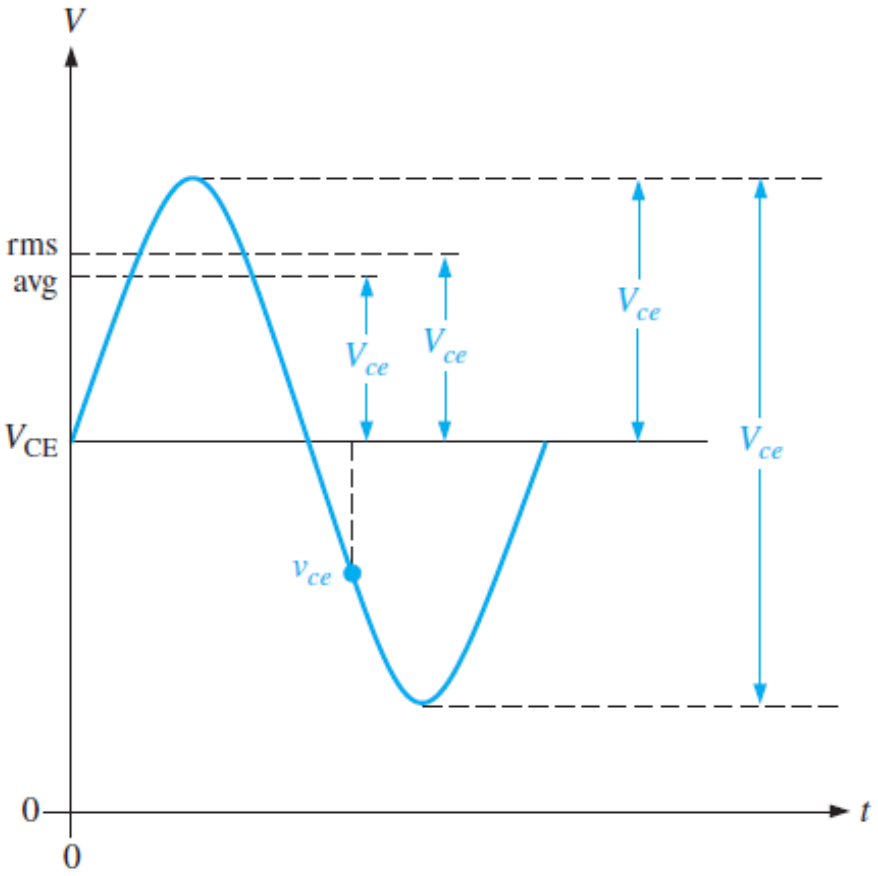
- Amplifiers designed to handle these small ac signals are often referred to as ***small-signal amplifiers.***



◀ FIGURE 6–2

An amplifier with voltage-divider bias driven by an ac voltage source with an internal resistance, R_s.

AC quantities



DC I_C, I_E, V_C, and V_{CE}

AC I_c, I_e, I_b, V_c, V_{ce}

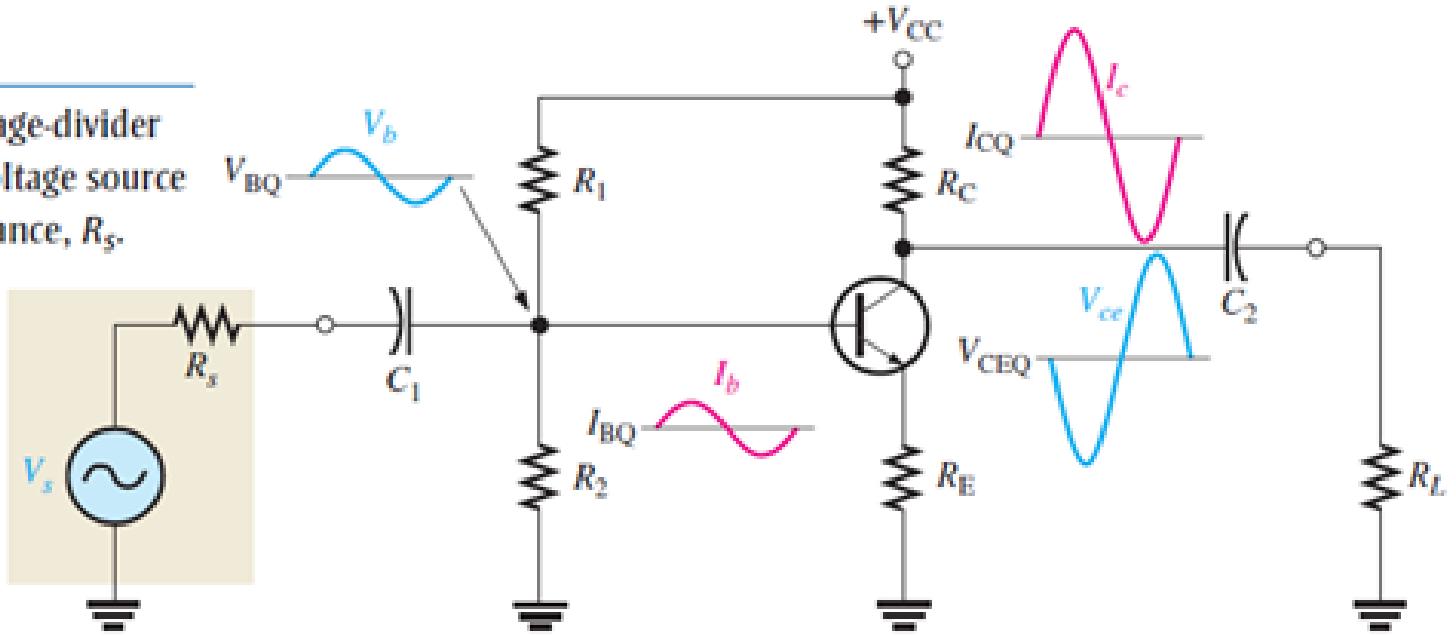
R_C is the dc collector resistance.
R_c is the ac collector resistance
r'_e internal ac emitter resistance

- **Vce** can represent **rms**, **average**, **peak**, or **peak-to-peak**
- **Vce** is in **rms** will be assumed unless stated otherwise.

The Linear Operation

FIGURE 6–2

An amplifier with voltage-divider bias driven by an ac voltage source with an internal resistance, R_s.

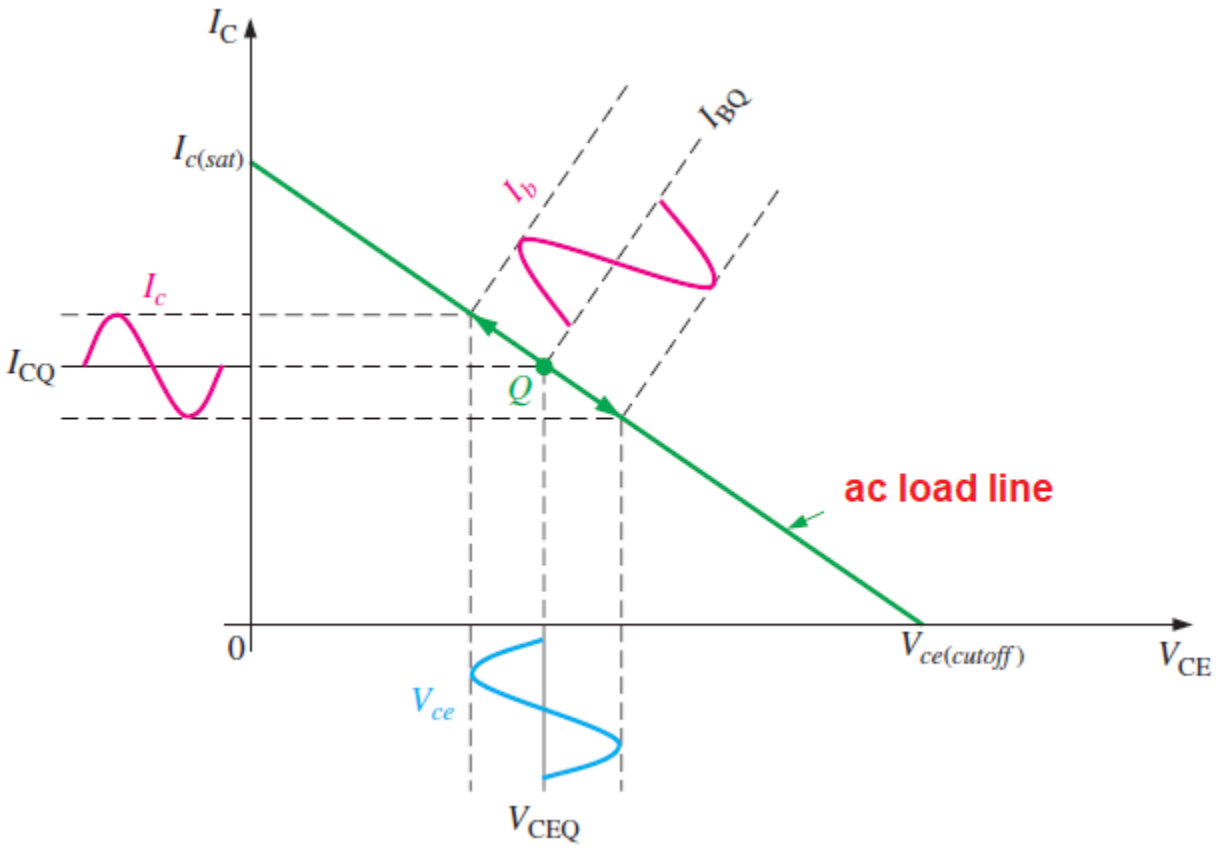


C1 : couple Vs to the base

C2 : couple RL to the collector

- **The coupling capacitors:** block dc thus prevent *Rs* and R_L from changing the dc bias voltages at the base and collector.
- **Operation:** Vs → V_b vary sinusoidally on V_{BQ} → I_b vary sinusoidally on I_{BQ}→I_C varies sinusoidally on I_{CQ} (in-phase)→ V_{ce} varies sinusoidally with V_{CE} (out of phase)
- A transistor produces a **phase inversion** between the base voltage and the collector voltage.

Graphical Picture of the Amplifier Operation



◀ FIGURE 6–3

Graphical ac load line operation of the amplifier showing the variation of the base current, collector current, and collector-to-emitter voltage about their dc Q-point values. I_b and I_c are on different scales.

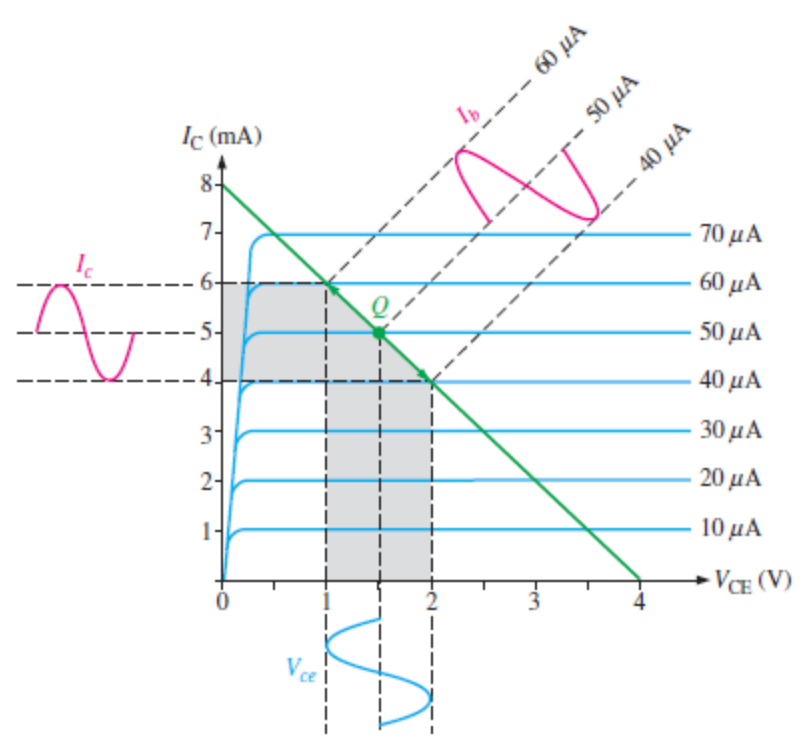
- **Note:** The ac load line differs from the dc load line because the effective ac collector resistance is RL in parallel with RC and is less than the dc collector resistance RC alone.

Graphical Picture of the Amplifier Operation

EXAMPLE 6–1

The ac load line operation of a certain amplifier extends 10 μA above and below the Q-point base current value of 50 μA, as shown in Figure 6–4. Determine the resulting peak-to-peak values of collector current and collector-to-emitter voltage from the graph.

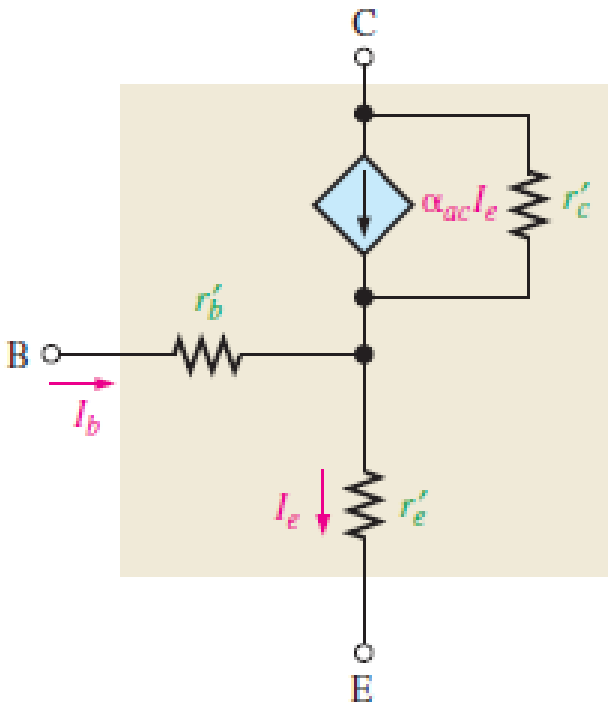
▶ **FIGURE 6–4**



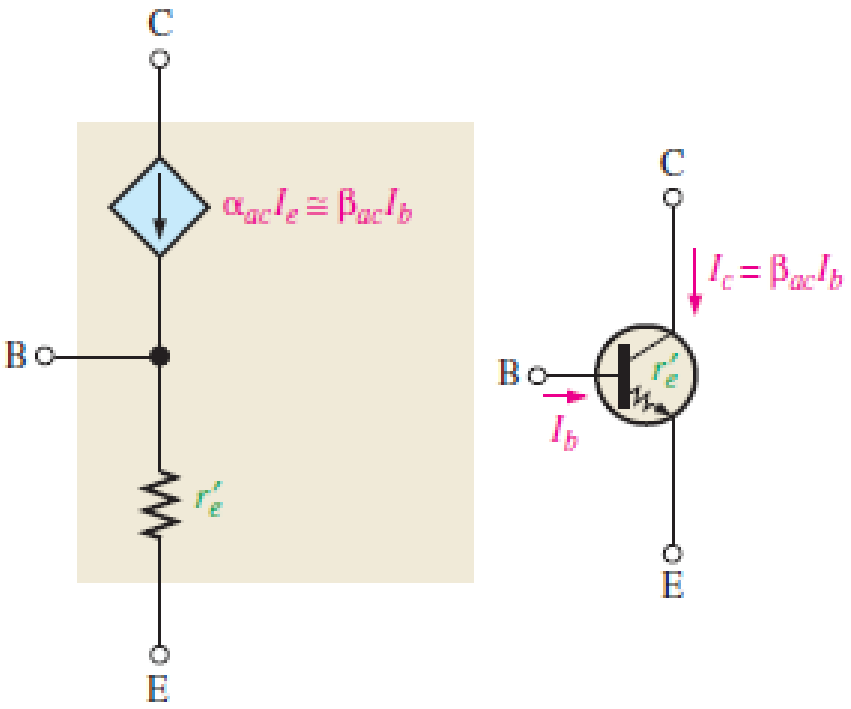
Solution Projections on the graph of Figure 6–4 show the collector current varying from 6 mA to 4 mA for a peak-to-peak value of **2 mA** and the collector-to-emitter voltage varying from 1 V to 2 V for a peak-to-peak value of **1 V**.

Transistor AC Models

- To visualize the operation of a transistor in an amplifier circuit, it is often useful to represent the device by a model circuit that uses various internal transistor parameters to represent its operation.



(a) Generalized *r*-parameter model for a BJT



(b) Simplified *r*-parameter model for a BJT