

BJT as Amplifiers

$$v_o = V_{CC} - R_C I_s e^{v_i/V_T}$$

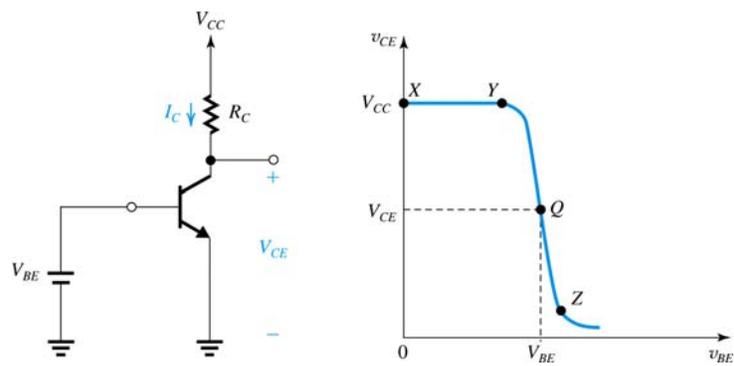
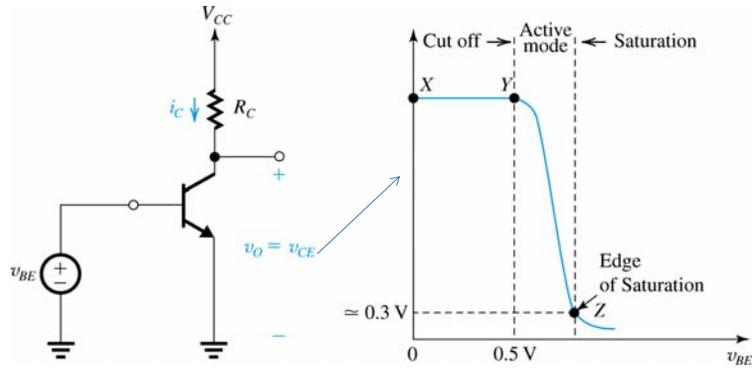
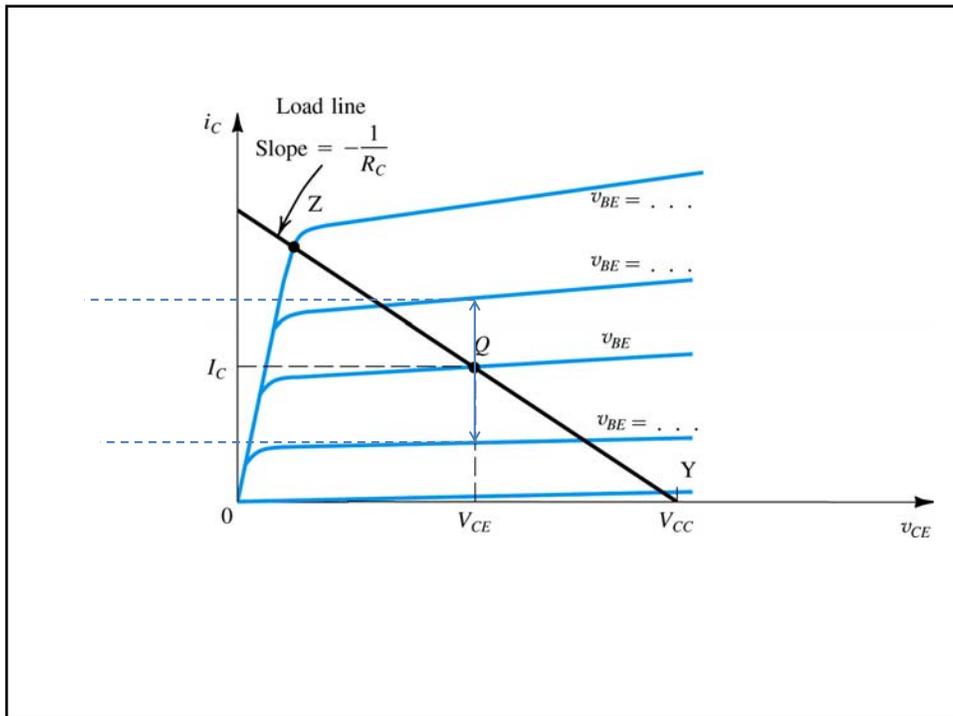
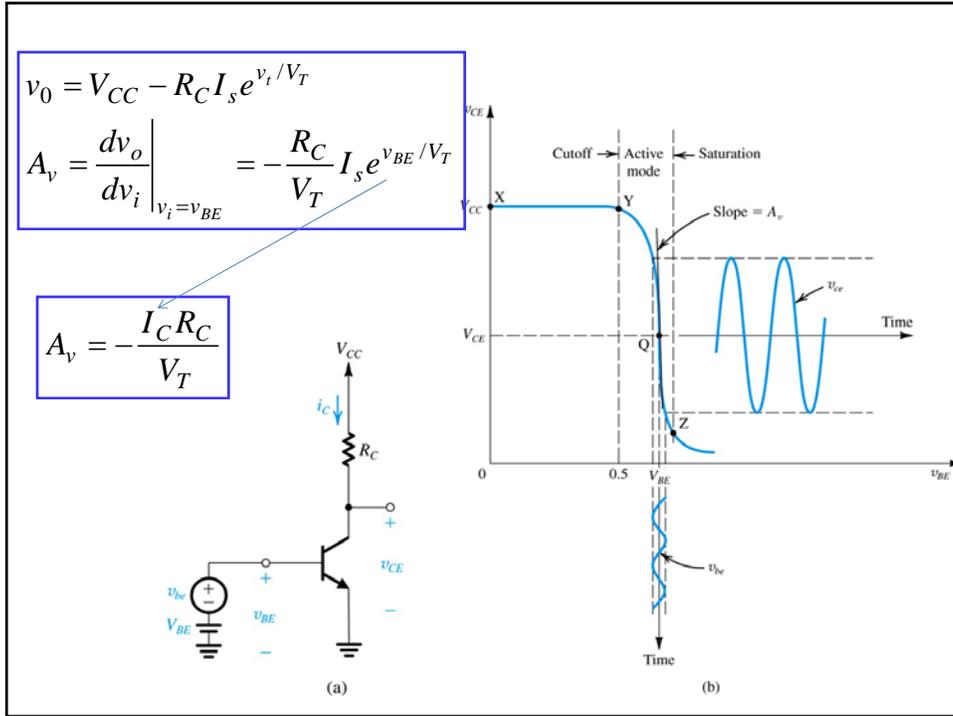
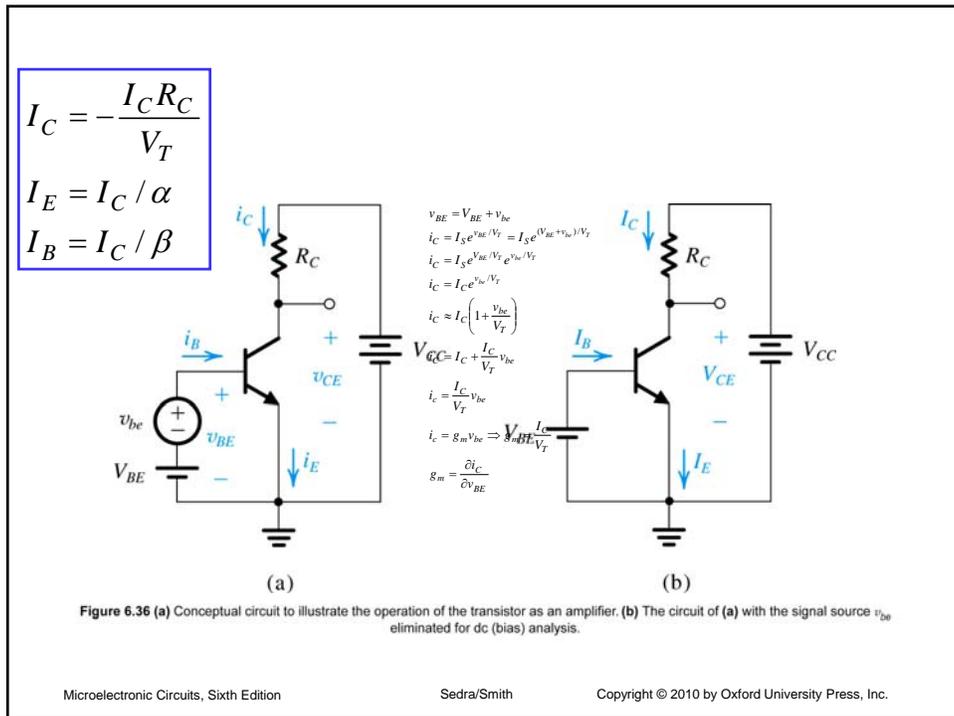
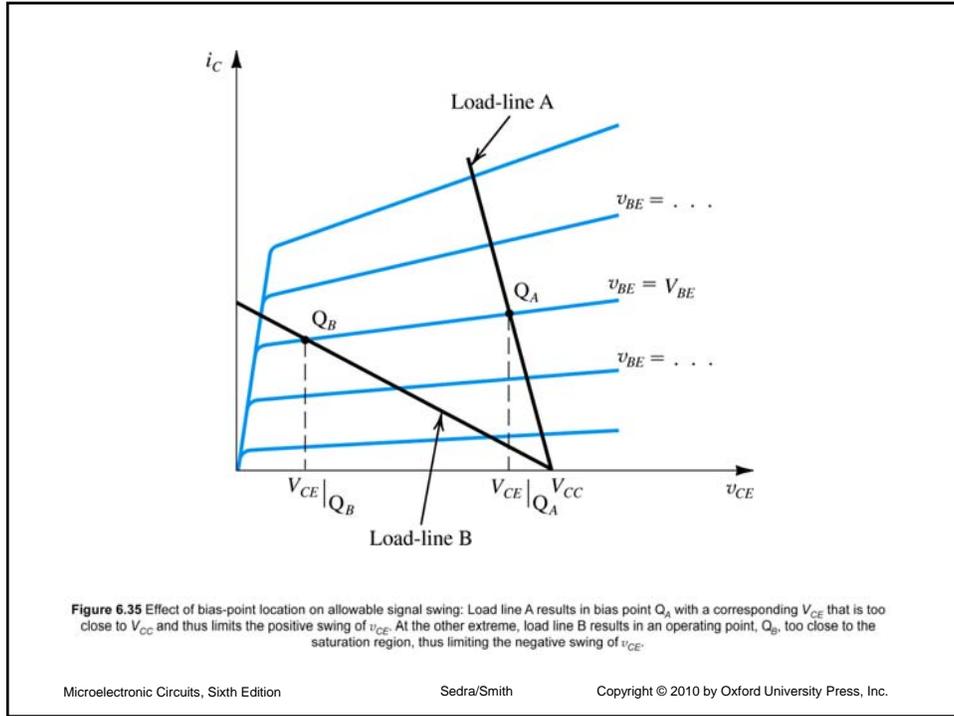


Figure 6.32 Biasing the BJT amplifier at a point Q located on the active-mode segment of the VTC.





$$v_{BE} = V_{BE} + v_{be}$$

$$i_C = I_S e^{v_{BE}/V_T} = I_S e^{(V_{BE} + v_{be})/V_T}$$

$$i_C = I_S e^{V_{BE}/V_T} e^{v_{be}/V_T}$$

$$i_C = I_C e^{v_{be}/V_T}$$

$$i_C \approx I_C \left(1 + \frac{v_{be}}{V_T} \right)$$

$$i_C = I_C + \frac{I_C}{V_T} v_{be}$$

$$i_c = \frac{I_C}{V_T} v_{be}$$

$$i_c = g_m v_{be} \Rightarrow g_m = \frac{I_C}{V_T}$$

$$g_m = \frac{\partial i_C}{\partial v_{BE}}$$

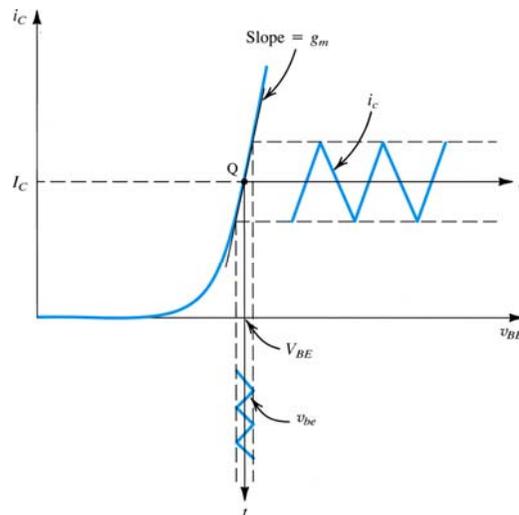
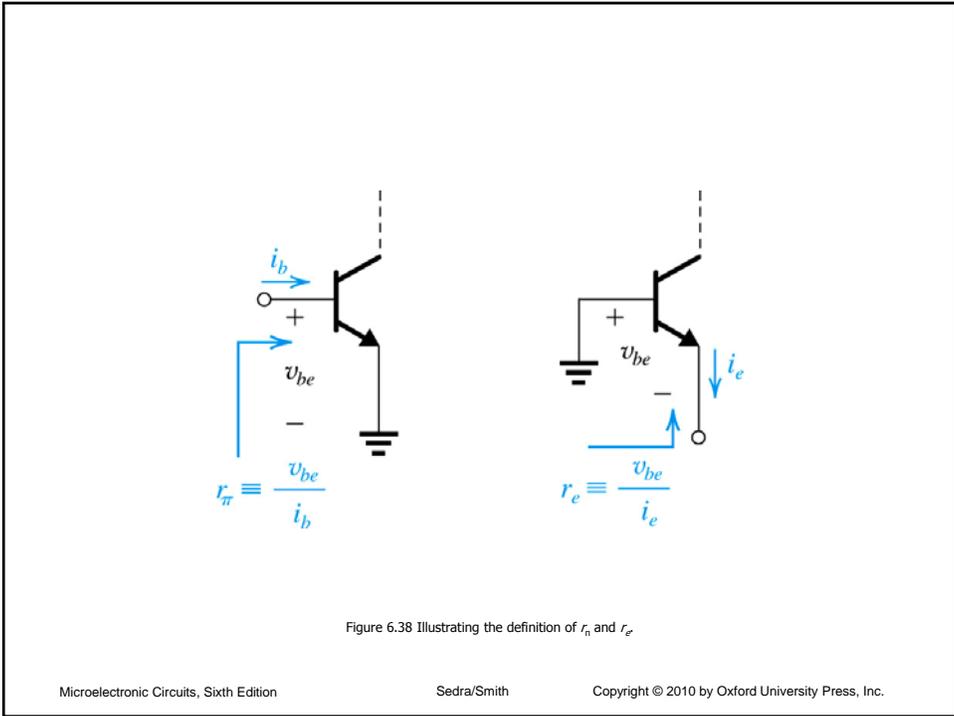
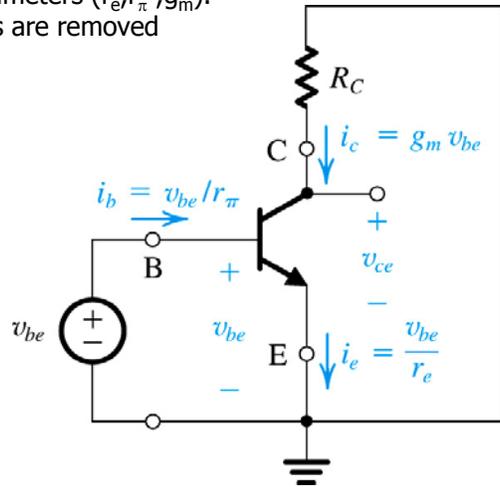


Figure 6.37 Linear operation of the transistor under the small-signal condition: A small signal v_{be} with a triangular waveform is superimposed on the dc voltage V_{BE} . It gives rise to a collector signal current i_c , also of triangular waveform, superimposed on the dc current I_C . Here, $i_c = g_m v_{be}$, where g_m is the slope of the i_C - v_{BE} curve at the bias point Q .



- The DC bias determine the circuit parameters (r_e, r_{π}, g_m).
- DC sources are removed



The Hybrid- π Model

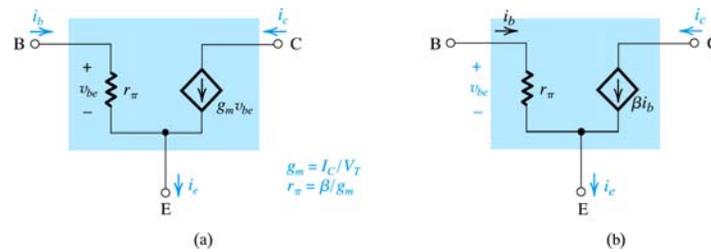


Figure 6.40 Two slightly different versions of the hybrid- π model for the small-signal operation of the BJT. The equivalent circuit in (a) represents the BJT as a voltage-controlled current source (a transconductance amplifier), and that in (b) represents the BJT as a current-controlled current source (a current amplifier).

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The T Model

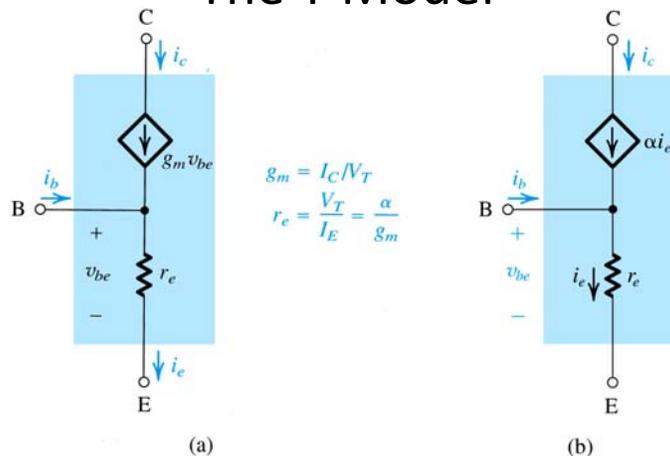
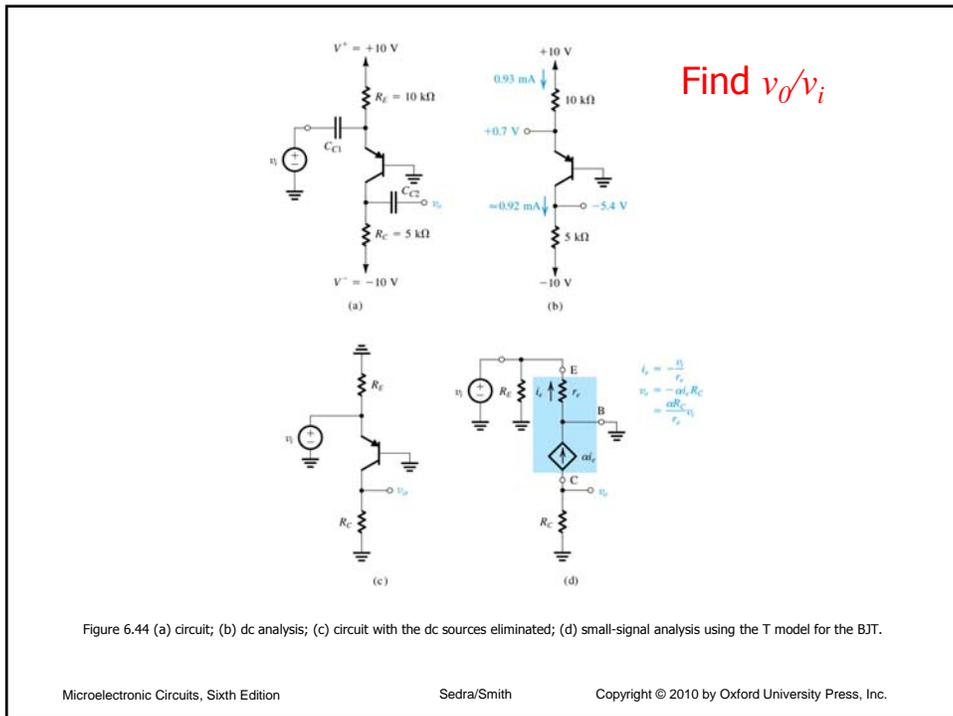
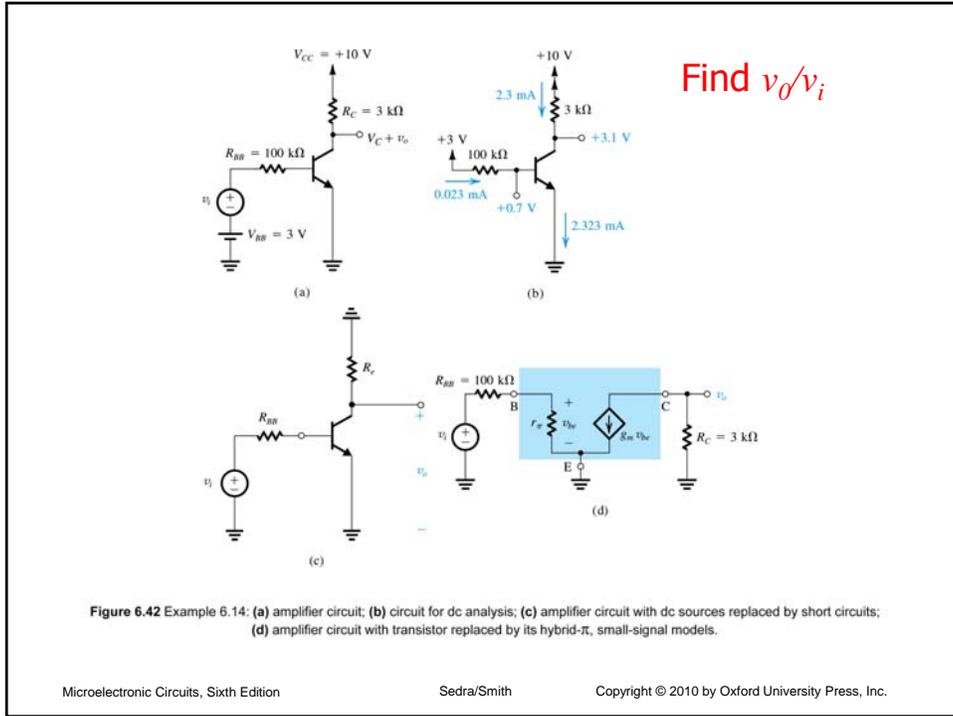


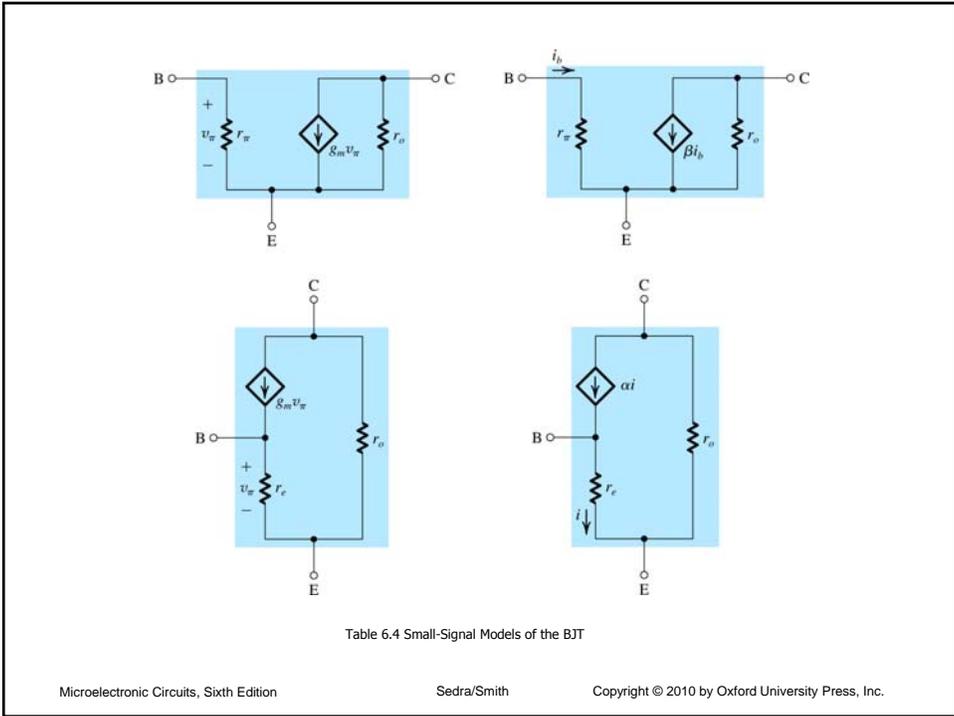
Figure 6.41 Two slightly different versions of what is known as the *T model* of the BJT. The circuit in (a) is a voltage-controlled current source representation and that in (b) is a current-controlled current source representation. These models explicitly show the emitter resistance r_e rather than the base resistance r_π featured in the hybrid- π model.

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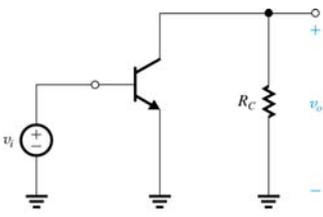
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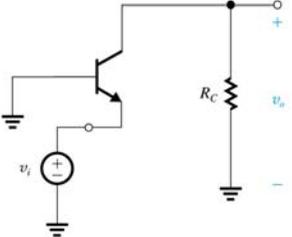




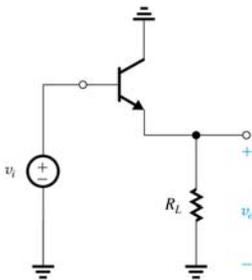
Basic Amplifier Configuration



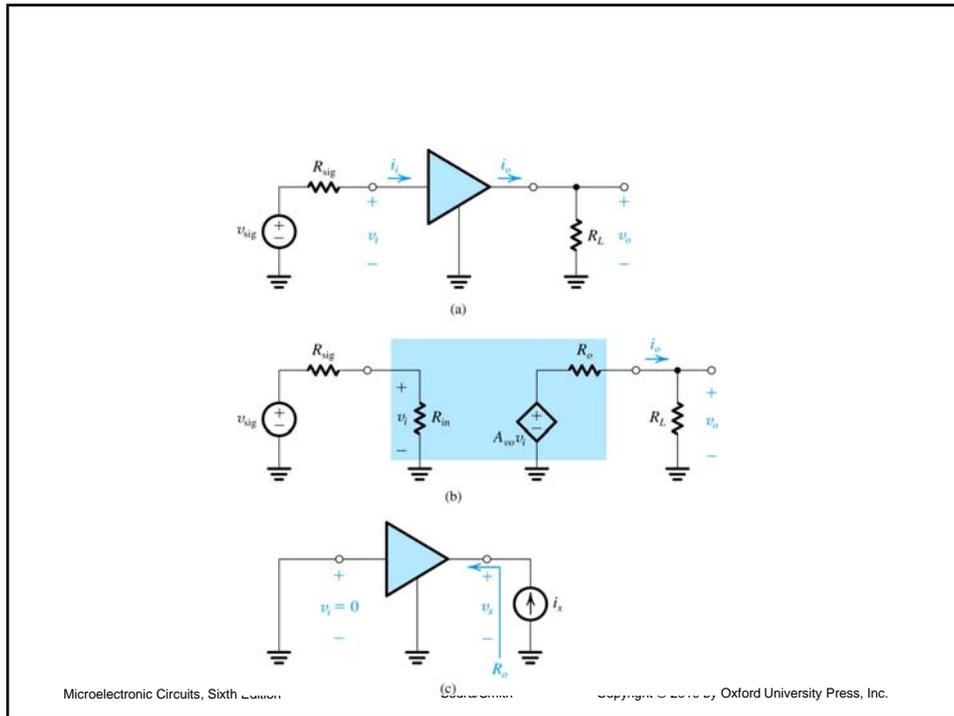
(a) Common-Emitter (CE)



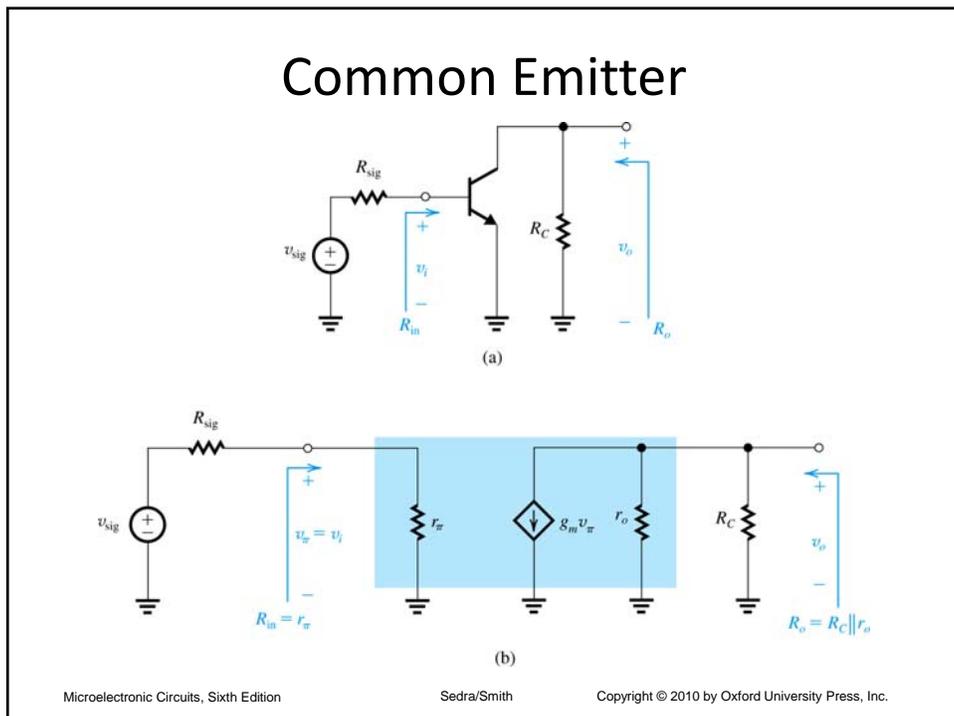
(b) Common-Base (CB)



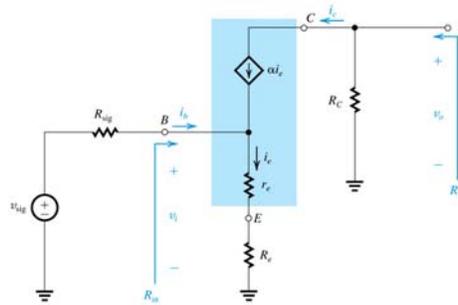
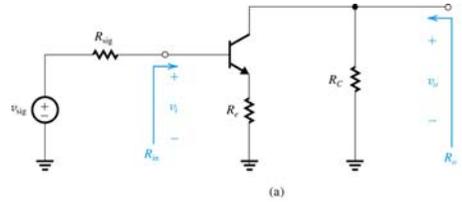
(c) Common-Collector (CC) or Emitter Follower



Common Emitter



Common Emitter with R_E



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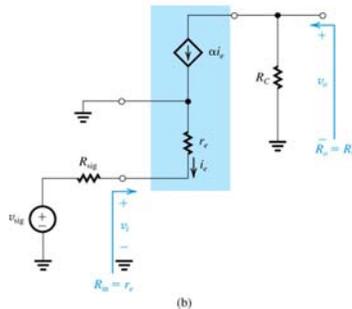
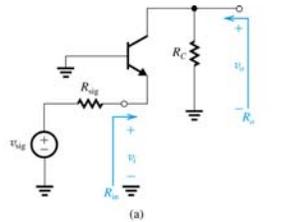


Figure 6.53 (a) CB amplifier with bias details omitted; (b) Amplifier equivalent circuit with the BJT represented by its T Model.

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