product increases with increasing R_L and decreases with increasing R_s. Even if we know the gain-bandwidth product at a particular R_s and R_L, we cannot use the product to determine the improvement, say, in bandwidth corresponding to a sacrifice in gain. For if we change the gain by changing R_s or R_L or both, generally, the gain-bandwidth product will no longer be the same as it had been.

Summary The high-frequency response of a transistor amplifier is obtained in this chapter in terms of the transistor parameters g_m, $r_{b'e}$, $r_{bb'}$, C_e, and C_c. We shall now show that these may be obtained from the four independent parameters h_{fe}, f_T, h_{ie}, and $C_o = C_{ob}$.

From the operating current I_C and the temperature T, the transconductance is obtained [Eqs. (11-16)] as $g_m = |I_C|/V_T$ and is independent of the particular device under consideration. Knowing g_m, we can find, from Eqs. (11-16) and (11-23),

$$r_{b'e} = \frac{h_{fe}}{g_m} \qquad r_{bb'} = h_{ie} - r_{b'e} \qquad C_e \approx \frac{g_m}{2\pi f_T}$$

If R_s and R_L are given, all quantities in Eq. (11-37) or (11-41) are known. We have therefore verified that the frequency response may be determined from the four parameters h_{fe}, f_T, h_{ie}, and C_c. Hence these four are usually specified by manufacturers of high-frequency transistors.

11-10 EMITTER FOLLOWER AT HIGH FREQUENCIES

In this section we examine the high-frequency response of the emitter follower shown in Fig. 11-14a. A capacitance C_L is included across the load because the emitter follower (due to its low output resistance) is often used to drive capacitive loads.

Writing nodal equations at the nodes B' and E, respectively, we have

$$G_s'V_s = [G_s' + g_{b'e} + s(C_c + C_e)]V_i' - (g_{b'e} + sC_e)V_e \tag{11-55}$$

$$0 = -(g + sC_e)V_i' + \left[g + \frac{1}{R_L} + s(C_e + C_L)\right]V_e \tag{11-56}$$

where

$$G_s' \equiv \frac{1}{R_s + r_{bb'}} \qquad \text{and} \qquad g \equiv g_m + g_{b'e} \tag{11-57}$$

If V_i' is eliminated from these equations, the voltage gain V_e/V_s as a function of s is obtained. The result, of the form given in Eq. (11-38), has one zero and two poles. The exact solution can be found by proceeding as in Sec. 11-8 (Prob. 11-18).