Example 5.2

Consider a pnp bipolar transistor with emitter doping of 10^{18} cm^{-3} and base doping of 10^{17} cm^{-3}. The quasi-neutral region width in the emitter is 1 μm and 0.2 μm in the base. Use m_n = 1000 cm^2/V-s and m_p = 300 cm^2/V-s . The minority carrier lifetime in the base is 10 ns.

Calculate the emitter efficiency, the base transport factor, and the current gain of the transistor biased in the forward active mode. Assume there is no recombination in the depletion region.

Solution

The emitter efficiency is obtained from:

$$g_E = \frac{1}{1+\frac{D_{p,E} N_B w_B'}{D_{n,B} N_E w_E'}} = 0.994$$

The base transport factor equals:

$$a_T = 1 - \frac{w_B'^2}{2 D_{n,B} t_n} = 0.9992$$

The current gain then becomes:

$$b = \frac{a}{1-a} = 147.5$$

where the transport factor, a, was calculated as the product of the emitter efficiency and the base transport factor:

$$a = g_E a_T = 0.994 \times 0.9992 = 0.993$$