Tutorial 2: BJT

B. G. Streetman (6th Edition): End-of-Chapter 7 Problems

7.7,10,11) A p^+-n-p Si transistor has a uniform area of 2×10^{-4} cm^2 and base width W_b of 1 μm. The emitter doping is 10^{18} and base doping is 10^{16} cm^{-3}. The hole life time in the base is 1 μs, and the mobility can be found from figure 3-23 (or see below).

(a) calculate I_E and I_C, with V_{EB} = 0.6 V and Δp_C negligible.

(b) compare $I_B \approx \dfrac{qAW_b\Delta p_E}{2\tau_p}$ with I_E - I_C

(c) calculate γ, B, α and β. Assume the emitter is long compared with L_n and τ_n = 0.1 μs in the emitter.

(d) calculate the saturation current I_{ES}.

7.17) Assume the transit time for electrons across the base of an n-p-n transistor is 100 ps, and electrons cross the 1-μm depletion region of the collector junction at their scattering limited velocity (see below). The emitter-base junction charging time is 30 ps and the collector capacitance and resistance are 0.1 pF and 10 Ω, respectively. Find the cutoff frequency f_T.

7.22) A symmetrical n^+-p-n^+ Si bipolar transistor has the following properties:

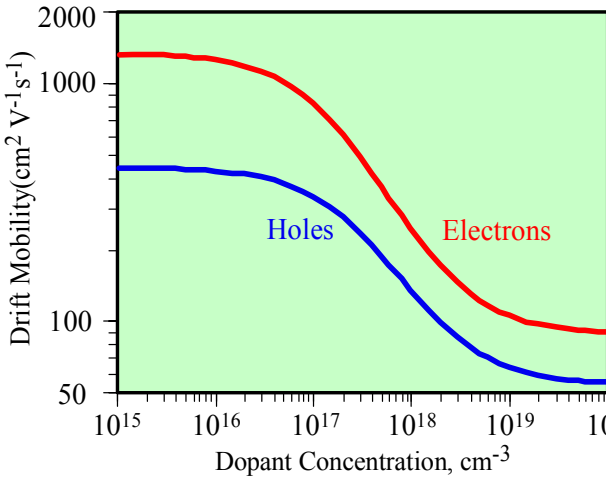
Emitter and collector	Base
$N_D = 10^{18}$ cm^{-3}	$N_A = 2\times10^{16}$ cm^{-3}
$\tau_n = \tau_p = 0.1$ μs	$\tau_n = \tau_p = 1$ μs

$A = 2\times10^{-4}$ cm^2

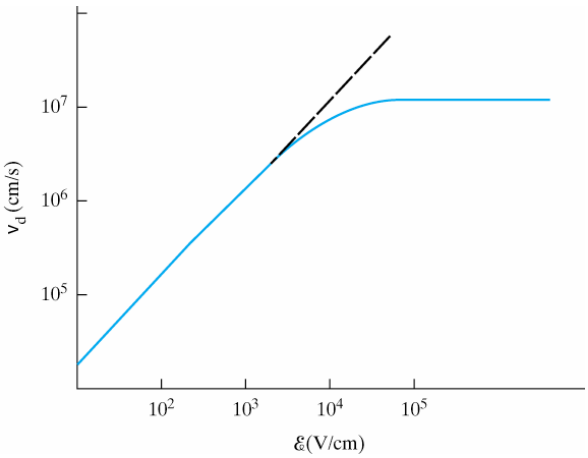
$W_b = 0.4\ \mu m$

(a) Calculate I_{ES}.

(b) Calculate I_B for V_{EB} = -0.7 V, V_{CB} = 4 V assuming $I_E = I_{En}$.



The variation of the drift mobility with dopant concentration in Si electrons and holes



electron drift velocity in Si

Self-study Book: อุปกรณ์สารกึ่งตัวนำ Example 6.3 pp.269-270