ECE 340 Homework XII Spring 2003

Due: Wednesday, April 09, 2003

1. Redraw Fig. 7-3 for an n^+-p-n transistor, and explain the various components of carrier flow and current directions.

2. Sketch the energy band diagram for an n-p-n transistor in equilibrium (all terminals grounded) and also under normal active bias (emitter junction forward biased, collector junction reverse biased). With the emitter terminal grounded, determine the signs (positive or negative) of the collector voltage V_{CE} and base voltage V_{BE}, relative to the emitter, that correspond to normal bias.

3. A symmetrical p^+-n-p^+ Si bipolar transistor has the following properties:

Emitter/Collector	Base	$A = 10^{-4}cm^2$
$N_a = 10^{18}/cm^3$	$N_d = 10^{16}/cm^3$	$W_b = 1\ \mu m$
$\tau_n = 0.1\ \mu s$	$\tau_p = 10\ \mu s$	
$\mu_p = 100\ cm^2/V\text{-}s$	$\mu_n = 1060\ cm^2/V\text{-}s$	
$\mu_n = 350\ cm^2/V\text{-}s$	$\mu_p = 380\ cm^2/V\text{-}s$	

   (a) Determine if the straight-line approximation can be applied to evaluate the excess carriers in the base region.

   (b) With $V_{EB} = 0.5$ V and $V_{CB} = -3$ V, calculate the base current I_B, assuming perfect emitter injection efficiency.

   (c) Assuming the emitter region is long compared to L_n, find an expression for injected electrons in the emitter. Determine the injected electron current at the emitter/base junction.

   (d) Calculate the emitter injection efficiency γ and the amplification factor β for part (c).