EE 203

1. In the BJT current derivation in class, we did a "quasi-ideal" treatment of the base. Now we will derive the same expressions without making this approximation. The treatment of the emitter and collector remains unchanged.

(a) Show that the minority carrier distribution in the base is

$$\Delta n_B(x) = \Delta n_B(0)\frac{\sinh\left(\dfrac{W-x}{L_{nB}}\right)}{\sinh(W/L_{nB})} + \Delta n_B(W)\frac{\sinh(x/L_{nB})}{\sinh(W/L_{nB})}$$

(b) Calculate $I_{En} = qD_{nB}\dfrac{\partial \Delta n_B(0)}{\partial x}$ and $I_{Cn} = qD_{nB}\dfrac{\partial \Delta n_B(W)}{\partial x}$.

(c) Show that in the forward active region, the base transport factor,
$\alpha_T = I_{Cn}/I_{En} = 1/\cosh(W/L_{nB})$. For $W/L_{nB} << 1$, derive the expression found in class.

(d) Show that in the forward active region, the emitter injection efficiency,

$$\gamma = \frac{I_{En}}{I_{En}+I_{Ep}} = \frac{1}{1+\dfrac{D_{pE}L_{nB}N_{AB}\sinh(W/L_{nB})}{D_{nB}L_{pE}N_{DE}\cosh(W/L_{nB})}} .$$

For $W/L_{nB} << 1$, derive the expression found in class.

2. At $V_{CE} = 0$, the family of I_C vs. V_{CE} curves seen on a curve tracer do not pass through the origin.

(a) Using the Ebers Moll model, write an expression for Ic in terms of the Ebers Moll parameters and V_{BE} for $V_{CE} = 0$.

(b) For a n+/p/n$^-$ BJT, taking into account the relative magnitudes of the Ebers Moll parameters, sketch the curves at $V_{CE} = 0$.

3. Suppose we wish to measure the I-V characteristics of the E-B junction of a $n^+ / p / n^-$ BJT. Does it matter whether we leave the collector open or shorted to the base? Use the Ebers Moll model to prove your answer.