

ECSE-2210 Microelectronics Technology
Class Activity 20

1. In a BJT, indicate what happens (**increase, decrease or no-effect: choose one and understand “why”**):
 - a. to γ if we increase the emitter doping?
 - b. to γ if we increase the base doping?
 - c. to γ if we increase the collector doping?
 - d. to α_T if we increase the base width?
 - e. to α_T if we increase the lifetime in the base?
 - f. to α_T if we increase the C-B reverse voltage?

2. The base transport factor, α_T , is I_C/I_{EP} . Using the equations derived in class for I_C and I_{EP} , show that the base transport factor is given by (see equation 11.42 in the textbook)

$$\alpha_T = \frac{1}{1 + \frac{W_B^2}{2L_B^2}}$$

3. (Derivation of equation 11.41 in the textbook): Show that the emitter injection efficiency is given by:

$$\gamma = \frac{1}{1 + \frac{D_E N_B W_B}{D_B N_E L_E}}$$

4. A sample set of assumed and measured material parameters for a pnp BJT is given in the table below. Calculate base transport factor, emitter injection efficiency, common base current gain (also called collector-to-emitter current gain) and common emitter current gain (also called collector-to-base current gain).

Emitter	Base	Collector
$N_E = 10^{18} \text{ cm}^{-3}$	$N_B = 10^{16} \text{ cm}^{-3}$	$N_C = 10^{15} \text{ cm}^{-3}$
$\mu_E = 263 \text{ cm}^2/\text{Vs}$	$\mu_B = 437 \text{ cm}^2/\text{Vs}$	$\mu_C = 1345 \text{ cm}^2/\text{Vs}$
$D_E = 6.81 \text{ cm}^2/\text{s}$	$D_B = 11.3 \text{ cm}^2/\text{s}$	$D_C = 34.8 \text{ cm}^2/\text{s}$
$\tau_E = 10^{-7} \text{ s}$	$\tau_B = 10^{-6} \text{ s}$	$\tau_C = 10^{-6} \text{ s}$
$L_E = 8.25 \times 10^{-4} \text{ cm}$	$L_B = 3.36 \times 10^{-3} \text{ cm}$	$L_C = 5.90 \times 10^{-3} \text{ cm}$
	$W_B = 2 \times 10^{-4} \text{ cm}$	