UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Electrical and Computer Engineering

Homework 5 – due December 8, 2017 by 5:00pm

1. An *n-p-n* BJT has emitter, base and collector doping levels of 10^{19} cm^{-3}, 5x10^{18} cm^{-3}, and 10^{17} cm^{-3}, respectively. It is biased in the normal active mode, with a base-emitter voltage V_{BE} = 1V and a collector-emitter voltage V_{CE} = 5V. If the neutral base width is 200 nm and the neutral emitter is 5 μm wide, calculate the emitter current density J_E, the emitter injection efficiency γ, and the base transport factor α_T. Assume electron and hole mobilities of 500 and 100 cm^2/V-s, respectively, in the emitter, and 800 and 250 cm^2/V-s, respectively, in the base. The device gets heated up to 400 K during operation such that $n_i = 10^{12}$ cm^{-3}, and ε_r = 15. Qualitatively sketch the device structure showing the minority carrier concentrations in the emitter and the base, and sketch the band diagram under bias below it. Assume the minority carrier lifetimes are 10 ns everywhere.

2. Problem 7.20 in Streetman.

3. For the BJT in the previous problem, calculate α, β, I_E, I_B, and I_C for the two values of V_{EB}.

4. Reading Assignment: *Streetman*: Ch. 7 (sections 7.1-7.2 and 7.4-7.6)