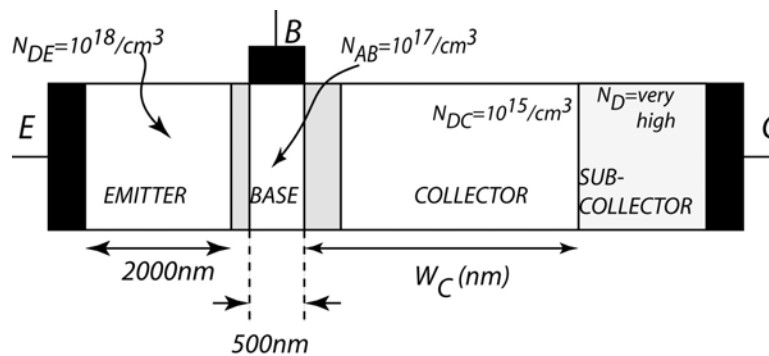

EE566 Solid State Devices

Spring 2004
Dept of Electrical Engineering
University of Notre Dame
Instructor: Debdeep Jena (djena@nd.edu, x8835)

2nd Mid-Term Exam 03/29/2004

Problem(25 Points)



Consider the Si BJT shown above. Note the doping densities carefully, and the fact that the emitter doping is such that we can neglect bandgap narrowing. Assume $T=300\text{K}$, and excess minority carrier density at an ohmic contact to be zero. Use the following for your calculations:

$$\epsilon_S = 11.7\epsilon_0 \mid \mu_n = 1500\text{cm}^2/\text{V}\cdot\text{s} \mid \mu_p = 450\text{cm}^2/\text{V}\cdot\text{s} \mid \tau_n = \tau_p = 0.5\mu\text{s} \mid n_i^2 = 4.46 \times 10^{19}/\text{cm}^6 \mid F_{BR} = 3 \times 10^5 \text{ V/cm}$$

- Sketch the *minority carrier distribution* in the BJT with the E-B junction forward biased at 0.5V, and the B-C ALSO forward biased at 0.5V.
- Sketch the *minority carrier distribution* in the BJT with the E-B junction forward biased at 0.5V, and the B-C now reverse biased at 5V.
- Find the emitter injection efficiency γ_E , base transport factor α_T , and the corresponding current gain β_F .
- What is the collector width W_C such that it is *totally* depleted at $V_{CB}=0$ Volt? Make reasonable assumptions.
- With this W_C , find the reverse-bias collector-base voltage V_{CB} at which the BJT breaks down. Assume the sub-collector is doped very heavily. Breakdown field for Si is given above.
- How can you improve the CB breakdown voltage? What is the price you pay?

NOTE:

Sketches, sketches with proper LABELS!! (wherever the situation demands). State and justify your approximations clearly, and use your intuition to cut down on the math.