

ELEG 646; ELEG 446 - Nanoelectronic Device Principles – Spring 2011

Homework #10 - due Friday, 29 April 2011, in class

1. Problem 6.1 in chapter 6 of Muller & Kamins, p. 321 in 3rd edition.
2. Consider the thermionic emission model of a Schottky barrier diode, and use the standard I-V equation with ideality factor η . The measured forward current at 300 K is 3×10^{-8} A at 0.2 V and 1×10^{-6} A at 0.3 Volts. The diode area is 0.2 cm^2 and $\phi_B = 1 \text{ V}$. Calculate the saturation current I_s , the ideality factor η , and the value of A^* (Richardson's constant).
3. Draw the energy band diagrams for an ***n-p-n*** transistor when it is biased in (a) the saturation region, and (b) the cutoff region.
4. A symmetrical Ge p-n-p transistor with emitter-base and collector-base junctions, each 1 mm in diameter, has an impurity concentration of $5 \times 10^{15} \text{ cm}^{-3}$ in the base and 10^{18} cm^{-3} in the emitter and the collector. The base-width is $10 \text{ }\mu\text{m}$, $\tau_B = 4 \times 10^{-6} \text{ sec}$, $\tau_E = 10^{-8} \text{ sec}$, and the emitter region is much longer than the diffusion length L_E . Calculate the current gains α and h_{FE} of the transistor. Take $D_B = 47 \text{ cm}^2 \text{ sec}^{-1}$ and $D_E = 52 \text{ cm}^2 \text{ sec}^{-1}$.
5. A Si n-p-n transistor has the following parameters at 300 K: $N_A = 5 \times 10^{16} \text{ cm}^{-3}$, $N_D(E) = 1 \times 10^{18} \text{ cm}^{-3}$, $W_B = 2 \text{ }\mu\text{m}$, $W_E = 0.2 \text{ }\mu\text{m}$, $\mu_B = 1000 \text{ cm}^2 \text{ V}^{-1} \text{ sec}^{-1}$, $\mu_p(E) = 150 \text{ cm}^2 \text{ V}^{-1} \text{ sec}^{-1}$, $\tau_B = 10^{-6} \text{ sec}$, and $\tau_E = 10^{-8} \text{ sec}$. The emitter-base junction area is 0.01 cm^2 , $I_E = 1 \text{ mA}$, and the collector-base junction is reverse biased by 2 V. Neglect carrier generation and recombination in the two junction depletion regions. (a) Calculate the emitter-base junction voltage and the excess electron concentration in the base at the edge of the emitter-base junction depletion region. (b) Calculate γ , α_T , and h_{FE} for the transistor.
6. Give the tentative title of your course design project (you are permitted to change it for the final submitted report).

Homework assignments will appear on the web at:
<http://www.ece.udel.edu/~kolodzey/courses/eleg646s11.html>

Include your name, due date, assignment number, and course number on each submission.