**ELEG 646; ELEG 446 - Nanoelectronic Device Principles – Spring 2005**
**Homework #8 (revised) - due Thursday, 5 May 2005, in class**

1. A p-n-p transistor with uniformly doped base, emitter, and collector regions has $I_E = 1.2$ mA. Sketch the minority carrier distribution in the base when (a) the collector is shorted to the base, (b) the collector is shorted to the emitter, and (c) the collector terminal is kept open.

2. The emitter and collector regions of a Si alloyed p-n-p transistor are heavily doped, and the impurity concentration in the base is $10^{15}cm^{-3}$. Calculate the base-width that will make the avalanche breakdown voltage equal to the punch-through voltage. The punch through voltage is given by: $V_{PT} = qN_DW_{Bo}^2/(2\varepsilon_s)$ , where $W_{Bo}$ is the metallurgical base width. Assume that avalanche breakdown occurs when the maximum field strength in the depletion region becomes $5 \times 10^5$V/cm. What minority carrier diffusion length and lifetime in the base are required to obtain a value of $\alpha = 0.95$? Assume $\gamma = 0.99$ and a reverse bias of 15 V at the collector-base junction.

3. The emitter current of a p-n-p transistor with $\alpha_N = \alpha_I$ is 0.5 mA when the emitter-base junction is forward biased and the collector is left open. (hint: use Ebers-Moll equation to obtain equation when $I_C = 0$). When the collector is shorted to the base, the emitter current rises to 25 mA. Use this expression to obtain the $\alpha$. Calculate $h_{FE}$ and the base-width ($W_B$) of the transistor assuming a minority carrier diffusion length of 20 μm in the base and the emitter efficiency to be unity (=1).

4. Problem 7.23 (a, only) page 377 in the text MKC.

5. Consider a Si double-gate n-channel JFET with the following parameters: $N_A = 3 \times 10^{18}cm^{-3}$, $N_D = 10^{15}cm^{-3}$, a = 2 μm, L = 20 μm, and Z/L = 5. Assume $\mu_n$= 1000 $cm^2$/V-sec and T = 300K. (a) Calculate the built-in voltage, the pinch-off voltage, and the value of the open channel conductance.

Homework assignments will appear on the web at:
http://www.ece.udel.edu/~kolodzey/courses/eleg646s05.html
Note: On each homework and report submission, you must please give your name, the due date, assignment number and the course number.