ECE 340
Test #1 Review

Problem #1

A silicon sample with $N_D = 10^{16}$ cm^{-3} donors is optically excited such that 10^{19} EHP/cm^3 are generated per second uniformly in the sample. The laser causes the sample to heat up to 450 K. The electron and hole lifetimes are both 10^{-6} seconds, $D_p = 12$ cm^2/s; $D_n = 36$ cm^2/s; and $n_i = 10^{14}$ cm^{-3} at T = 450 K. Find the quasi-Fermi levels and the change in the conductivity of the sample upon shining the light.

Problem #2

A portion ($0 \le x \le L$) of a silicon sample, uniformly doped with $N_D = 10^{15}$ cm^{-3} donors and maintained at room temperature, is subject to a steady state perturbation such that:

$$n \approx N_D$$
$$p = n_i(1 - x/L) + n_i^2/N_D$$

Since $n \approx N_D$, it is reasonable to assume that the electric field is approximately equal to zero in the region of interest. Given this, sketch the energy band diagram for the perturbed region specifically including E_c, E_i, E_v, F_n, and F_p on the diagram.

Problem #3

Given a bar-shaped layer of width W, length L, and depth d, and assuming an arbitrary $N_D(x)$ variation with the depth x from the surface of the layer, derive a formula to calculate the resistance of the layer.

Problem #4

The earth is hit by a mysterious ray that momentarily wipes out all minority carriers. Majority carriers are not affected. Initially in equilibrium and not affected by room light, a uniformly doped silicon wafer sitting on your desk is struck by the ray at time t = 0. The wafer doping is $N_A = 10^{16}$ cm^{-3}, $\tau_n = 10^{-6}$ s, and T = 300 K.

A. What is δn at $t = 0^+$ (i.e. just after time t = 0)?
B. Does generation or recombination dominate at $t = 0^+$?
C. Do low-level injection conditions exist inside the wafer at $t = 0^+$?
D. Find a formula for $\delta n(t)$ for $t > 0$.