ECE-606 Homework No. 7 Assigned: Oct. 11 Due: Oct. 18

1) For an abrupt p^+n silicon diode, the doping concentration in the n-region is 10^{16} per cm^3. The width of the n-region is 2 μm. Assuming this width is much smaller than the hole diffusion length, calculate the reverse saturation current at 300K and 400K. The area of the diode is 100 μm x 100 μm and the hole mobility is 350 $cm^2/V.s$ at both temperatures.

2) Solve SDF 6.10

3) A silicon p-n junction diode with area $\mathbf{A = 10\ \mu m^2}$, has doping $\mathbf{N_A = 10^{17}\ cm^3}$ on the p-side and doping $\mathbf{N_D = 10^{16}\ cm^3}$ on the n-side. Calculate the storage charge in the depletion region and the diffusion charge for an applied voltage equal to -1V (reverse-biased). Assume that the *p*-type region is much smaller than the diffusion length with $\mathbf{W_p = 500\ nm}$ but *n*-type region is long with hole diffusion length $\mathbf{L_p = 50\ \mu m}$.

4) Consider a one-dimensional p-n junction whose two conducting surfaces are metal layers at the two surfaces $x = -T_p$ and $x = T_n$. The enclosed volume is the semiconductor slice between the two parallel planes located at $x = -T_p$ and $x = T_n$. The space charge layer extend from $x = -x_p$ to $x = x_n$. Using Gauss theorem, prove that the total space-charge enclosed within the space-charge layer is zero.

5) Compute the position of the Fermi energy relative to the intrinsic Fermi level on the p-side of a p-n junction diode. Assume $N_A = 10^{18}\ cm^{-3}$. Assume room temperature condition prevails.

6) Perform a search and outline the basic steps in the fabrication of a discrete planar p-n junction diode. You can use the information available on the web to aid your answer.

7) Compare the plots of forward current-voltage characteristics of Ge, Si, and GaAs p^+n junction diode. Assume that the diodes have identical structures and doping concentration. Please give a short mathematical argument to support your I-V sketch.

   You will not secure any credit for drawing the characteristics without a proof/reasoning.