

ECE 132 - Homework #3

- 5.9** An abrupt Si p-n junction has $N_a = 10^{17} \text{ cm}^{-3}$ on the p side and $N_d = 10^{16} \text{ cm}^{-3}$ on the n side. At 300 K, (a) calculate the Fermi levels, draw an equilibrium band diagram, and find V_0 from the diagram; (b) compare the result from (a) with V_0 calculated from Eq. (5-8).
- 5.11** In a p^+ -n junction, the n side has a donor concentration of 10^{16} cm^{-3} . If $n_i = 10^{10} \text{ cm}^{-3}$, the relative dielectric constant $\epsilon_r = 12$, $D_n = 50 \text{ cm}^2/\text{s}$, $D_p = 20 \text{ cm}^2/\text{s}$, and the electron and hole minority carriers have lifetimes $\tau = 100 \text{ ns}$ and 50 ns , respectively, and a forward bias of 0.6 V, calculate the *hole diffusion current density* $2 \mu\text{m}$ from the depletion edge on the n side. If we double the p^+ doping, what effect will it have on this hole diffusion current?
- 5.12** A Si p^+ -n junction has a donor doping of $5 \times 10^{16} \text{ cm}^{-3}$ on the n side and a cross-sectional area of 10^{-3} cm^2 . If $\tau_p = 1 \mu\text{s}$ and $D_p = 10 \text{ cm}^2/\text{s}$, calculate the current with a forward bias of 0.5 V at 300 K.
- 5.19** A Si p-n junction with cross-sectional area $A = 0.001 \text{ cm}^2$ is formed with $N_a = 10^{15} \text{ cm}^{-3}$, $N_d = 10^{17} \text{ cm}^{-3}$. Calculate:
- Contact potential, V_0 .
 - Space-charge width at equilibrium (zero bias).
 - Current with a forward bias of 0.5 V. Assume that the current is diffusion dominated. Assume $\mu_n = 1500 \text{ cm}^2/\text{V-s}$, $\mu_p = 450 \text{ cm}^2/\text{V-s}$, $\tau_n = \tau_p = 2.5 \text{ ns}$. Which carries most of the current, electrons or holes, and why? If you wanted to double the electron current, what should you do?