1. (Modified Problem 5.9 from Streetman’s text)  
An abrupt Si p-n junction has Na = 4x10^{18} \text{cm}^{-3} on the p side and Nd = 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_{FB} from the diagram; (b) compare the result from (a) with V_{FB} calculated from Eq. (5-8).

2. (Modified Problem 5.10 from Streetman’s text.)  
Boron is implanted into an n-type Si sample (Nd = 10^{16} \text{cm}^{-3}), forming an abrupt junction of square cross section with area = 2 \times 10^{-3} \text{cm}^2. Assume that the acceptor concentration in the p-type region is Na = 3x10^{17} \text{cm}^{-3}. Calculate V_{FB}, W_n, w_p, Q^+ (total positive charge uncovered), and E_0 (electric field at the junction) for this junction at equilibrium (300 K). Sketch E and the charge density to scale, as in Streetman Fig. 512.

3. (Modified Problem 5.11 from Streetman’s text.)  
In a p^+ - n junction, the n side has a donor concentration of 10^{16} \text{cm}^{-3}.
If nᵣ = 10^{10} \text{cm}^{-3}, the relative dielectric constant εᵣ (K) = 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 τ = 100 \text{ns} and 50 \text{ns}, respectively, and a forward bias of 0.7 V, calculate the hole diffusion current density \nabla \mu from the depletion edge on the n side. If we double the p^+ doping, what effect will it have on this hole diffusion current?

4. (Modified Problem 5.12 from Streetman’s text.)  
A Si p^+ - n junction has a donor doping of 5 \times 10^{18} \text{cm}^{-3} on the n side and a cross-sectional area of 10^{-3} \text{cm}^2. If τ_p = 1 \mu s and D_p = 10 \text{cm}^2/\text{s}, calculate the current with a forward bias of 0.6 V at 300 K.

5. (Modified Problem 5.19 from Streetman’s text.)  
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 = 4x10^{18} \text{cm}^{-3}.
(a) Calculate: (a) Contact potential, V_{FB}.
(b) Space-charge (depletion layer) width at equilibrium (zero bias).
(c) 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{ms}. Which carries most of the current, electrons or holes, and why? If you wanted to double the electron current, what should you do?

6. (Modified Problem 5.23 in Streetman’s text.)  
Assume that an abrupt Si p-n junction with area 10^{-4} \text{cm}^2 has N_a = 2\times10^{18} \text{cm}^{-3} on the p side and N_d = 10^{17} \text{cm}^{-3} on the n side. The diode has a forward bias of 0.7 V. Using mobility values from Fig. 3-23 and assuming that τ_n = τ_p = 1 \mu s, plot I_p and I_n versus distance on a diagram such as Fig. 5-17, including both sides of the junction. Neglect recombination within W.
Figure 5.12
Space charge and electric field distribution within the transition region of a p-n junction with $N_d > N_o$:
(a) the transition region, with $x = 0$ defined at the metallurgical junction; (b) charge density within the transition region, neglecting the free carriers; (c) the electric field distribution, where the reference direction for $\varepsilon$ is arbitrarily taken as the $+x$-direction.