1) Problem 6.10 of Pierret.

2) Assume the ideal silicon diode below.
   a) Make a quantitative sketch of the carrier concentrations across the diode for forward and reverse bias.
   b) For a small forward bias of 0.2V, what is the total excess hole charge injected into the n-region if the area of the diode is 1 cm²? Is this equal to the total excess electron charge in the p-region?
   c) What is J₀ for the diode? If we increase the doping of the p-region to Nₐ = 1×10¹⁹ cm⁻³, how does J₀ change (state which terms change and in which direction)?

3) A real silicon p-n junction has Nₐ = 5×10¹⁶ cm⁻³ in the p-region and Nₐ = 2×10¹⁶ cm⁻³ in the n-region. Assume the diode area is 1 cm² and τₙ = τₚ = 1μs.
   a) If we apply a reverse bias of 5V, what is the junction leakage current? What is the source of this current?
   b) Can you derive a condition where the ideal diode equation leakage dominates?
   c) What is the reverse bias breakdown voltage for this diode?
   d) What is W at Vₘₙ?

4) A p-n⁺ diode (shown below) has an n⁺ region doped at 10¹⁹ cm⁻³ and a p region doped at 10¹⁵ cm⁻³. At what level of forward bias would an appreciable amount (0.1V) of voltage be dropped across the bulk regions? Assume τₙ = τₚ = 1μs.
5) [Problem 2, midterm exam #2, spring 2007]
In the reverse-biased diode below, a narrow beam of light is scanned across a p-n junction. The recombination/generation time is 0.1 μs.

a) Sketch the current produced by the light as a function of x across the entire device.

b) The light has a cross-sectional area of 1 μm² (ignore diffraction). The diode is 10 μm wide (along y) and 10 μm thick (along z), and is doped at 10^{16} cm^{-3} on both sides. Estimate the current through the device if i) the light is off and ii) if the light is centered on the depletion region and generates G_{L}=10^{23} cm^{-3} s^{-1}.