**Question 3**

Consider a silicon pn junction diode at room temperature with:

EG = 1.1 eV VBI = 950 meV

= 4.0 eV

S = 12

ND = 5x1017 cm-3 NA = 5x1018 cm-3

DP = 5 cm2/sec DN = 4 cm2/sec

The n-bulk region and p-bulk region are both short compared to the respective

minority-carrier diffusion lengths, with lengths of WN and WP, respectively.

WN = WP = 100 nm

b) For small forward biases, we expect a non-ideal region with current ~ e qV/2kT.

Explain the dominant conduction mechanism in this region, using appropriate

diagrams as necessary.

c) For large forward bias, the current deviates from ideal due to potential drop

across the bulk regions. For this part, you may assume that the current through

the bulk region corresponds to drift current.

i) State whether the n-bulk or p-bulk has a larger voltage drop.

ii) Estimate the current density corresponding to a point where the actual

current is 1/e times the ideal current (you can ignore the side with lower

voltage drop).

d) Reverse-bias breakdown typically occurs at a critical field of EC=4x105 V/cm.

Calculate the reverse-bias breakdown voltage.

**Question 4**

This question has three parts.

a) Consider the semiconductor region shown below. The semiconductor is

homogeneous, except the left region is under steady illumination, and the right

region is not illuminated. The left region has a length L1 >> Lp. The right

region has a length L2 << Lp. A contact at the right end (x = L2) extracts all

excess minority carriers. Find the excess minority carrier concentration

versus position (you do not need to consider the region near x = -L1). Your

answer should be a formula.



b) Suppose that the semiconductor in part (a) has ND = 1x1017 cm-3, ni = 1x1011

cm-3 and EG = 1.0eV. Draw an appropriate band diagram for **equilibrium**

**conditions.**

c) Next, consider the **non-equilibrium** situation described in part a). Draw a

new band diagram showing the electron and hole quasi-Fermi levels.

**Question 2**

Consider a region of p-type semiconductor with length L << the minority carrier

diffusion length. At x=0, an excess minority carrier density of np0 is injected.

A contact at x=L can extract excess minority carriers reaching this point, with a

surface recombination velocity of sg.

a) Find an expression for np (x). Your solution should clearly show each

major step.

b) Find an expression for the diffusion current density at x=0, Jn(0).