EE566 Solid State Devices

Spring 2006
Dept of Electrical Engineering
University of Notre Dame
Instructor: Debdeep Jena (djena@nd.edu, x8835)

Assignment 3
Posted: 02/04/2006
Due: 02/10/2006

Reading
Chapter 4 of textbook.

Problem 1 (Practice problem)[1]
Problem 4.3 from the textbook. Remember what we learnt in the class, and plot the charge-field-band diagram even though the problem asks for less. Label everything (built-in voltage, whether curvature of bands are linear or parabolic, etc).
Next, use 1D Poisson to simulate the same, and compare with your results. Comment on the errors introduced by the depletion approximation.

Problem 2 (Growers' paradox)
Problem 4.26 from the textbook.

Problem 3 (Exact solution of Poisson's equation)
Consider a n^- - n^+ homojunction made of GaAs. Let the doping densities on the two sides of the junction be $N_{D1}=10^{15}/\text{cm}^3$ and $N_{D2}=10^{17}/\text{cm}^3$, and the two sides to be long (>2000nm).

a) Find the potential barrier to electron flow across the junction. Is the junction ohmic or rectifying?
b) Sketch (qualitatively) the charge-field-band diagram for the junction. Denote the variation of the bands across the junction (parabolic, exponential, flat), and relate them to the Debye lengths on the two sides.
c) Calculate the maximum electric field at the junction *exactly*. (Do not neglect Gummel corrections!).
d) Simulate this band diagram using 1D Poisson. Compare the simulated maximum electric field with your calculated *exact* value in part c), and the smearing length of the free charge densities on the two sides with your calculation of Debye lengths in part b). Are they consistent?

Problem 4 (A planar-doped electron barrier)
Problem 4.25 from the textbook.

---

[1] Remember to use proper units and label every figure/plot. Use natural scales such as nm for length, KV/cm for electric fields, and eV for energies. Turn in your answers worked out neatly. Please attach this question sheet to your solution when you turn it in.