EE534P-Device Simulation Lab

Problem Sheet 5

Numerical solution of Poisson's equation with Maxwell-Boltzmann distribution of carrier density:

a. Assuming electrons as the only type of carriers and an undoped semiconductor, write the appropriate form of poisson's equation for electrostatics (assume that the current is zero, and Maxwell-Boltzmann statistics for carriers).

b. Discretize the above equation such that finite difference method could be used to solve the same.

c. List out the general form for Jacobian for the above set of equations.

d. Consider a semiconductor (say, Silicon) of thickness 200μm. Assume that one end (A) is held at at 100mV while the other (B) is held at zero potential. Using a-c given above, solve for this system using Newton's method. Use a linearly varying potential profile as the initial guess. Plot the potential and carrier density profiles.

e. Repeat (d) for applied biases like 200mV, 400mV, and 600mV. Analyse your solutions.

f. Assume that SiO_2 of thickness 20nm is deposited at the end A and the potential is applied across the SiO_2 and the Semiconductor. Modify your code in (d) and find the carrier density profiles inside the semiconductor for an applied bias of 1V. Comment on your results.