

EECS 277C Nanotechnology

Problem Set #1

Due Monday, May 2, 2005

- 1) Using Moore's law, and available empirical data from Moore's most recent ISSCC presentation, calculate the year in which the size of a transistor will be the size of a single atom. Do you expect this to occur in your lifetime?
- 2) Compare the number of bits that are contained in a single human cell in the form of DNA to the amount of memory in your home computer. Which has more information storage capacity, a single cell or your home computer? Which has more information density?
- 3) Estimate the gate capacitance of a modern transistor. Now, calculate how much energy it costs to add one electron to the gate (e^2/C). Is this energy larger or smaller than a typical thermal energy ($k_B T$)?
- 4) Calculate the density of states in a 2 dimensional world.
- 5) Calculate the density of states in a 1 dimensional world.
- 6) Calculate the probability for an electron to tunnel through a 1 nm barrier that is 10 eV high. This is a good approximation for the tunnel junction shown in class.
- 7) Calculate the Fermi energy for a piece of aluminum. Calculate the quantum mechanical wavelength of an electron with energy equal to the Fermi energy. (Hard unless you know quantum mechanics).
- 8) For a 2 dimensional electron gas in GaAs with a density of 10^{11} cm^{-2} , calculate the Fermi energy and the Fermi wavelength. (This will be important when we discuss quantum dots and quantum point contacts.)
- 9) In figure 4 of Giaver's Phys Rev paper, the I-V curve is not a straight line. Can you think of reasons why?