EECS 277C Nanotechnology HW #2

1. Estimate the gate capacitance of a modern transistor. Assume a parallel plate capacitor with k=10, d= 10 nm, L=W=0.1 microns. 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_BT)?
2. Calculate the density of states in a 2 dimensional world.
3. 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. Use the formula below:

$$T = \left[1 + \frac{V_0^2 \sinh^2[ka]}{4E(V_0 - E)}\right]^{-1}$$

$$k = \sqrt{2m(V_0 - E)/\hbar^2}$$

$$V_0 = 10eV$$

$$E = 5eV$$

4. A device shows Coulomb blockade at temperatures only well below 300 K. What is it's size? (i.e. what is the capacitance of the tunnel barrier?)