HW #2
Due September 26 (Tuesday) in class

1. We have derived the expressions for the three-dimensional and two-dimensional electron density of states in class. Follow the same procedure, derive the one-dimensional electron density of state function for a "quantum wire" with dimension of L_x and L_y in the x and y direction, and unconfined in the z direction. Assume the electron effective mass $m_e^* = 0.067 \cdot m_0$, where m_0 is the free electron mass.
   a. Find the E-k (energy-vs-electron wavevector) relation? For simplicity, assume infinite potential barrier.
   b. Derive the 1-D electron density of state function, $\rho_{1D}(E)$.
   c. If $L_x = L_y = 10$ nm, plot $\rho_{1D}(E)$ for the first three energy states with E in eV.

2. Consider a "quantum box" (also called quantum dot) with dimensions of L x L x L. Assume the electron effective mass $m_e^* = 0.067 \cdot m_0$, where m_0 is the free electron mass.
   a. Find the E-k relation for the quantum box. For simplicity, assume infinite potential barrier.
   b. Derive the 0-D electron density of state function, $\rho_{0D}(E)$.
   c. If L = 10 nm, plot $\rho_{0D}(E)$ for the first five energy states with E in eV. Please note that some energy states are degenerate (i.e., states with different quantum numbers might have the same energy). ** Hint: the density of states is discrete. Please use a delta function to represent the density of state, i.e., $\rho_0(E) = \sum_n a_n \delta(E - E_n)$, where E_n is the energy of the n-th state, while a_n is the number of degeneracy of that state.
   d. For L= 10 nm, find the number of electrons *inside* the quantum box when the Fermi energy is 50 meV above the lowest energy state. For simplicity, consider T = 0 K. Note that each state accommodates two electrons (spin up and spin down).
   e. Continued with Part d), find the electron concentration *inside* the quantum box.