ECE 447/547 (Semiconductor Devices)
Southern Illinois University at Carbondale

Homework 03

Q1.
a) Why do we need to calculate the density-of-states function for electrons?
b) Derive the expressions for density-of-states for free electrons in a 2-D and 1-D system. Compare your findings with that for a 3-D system (that was derived in the class).
c) For a free electron in a 3-D system, calculate the density of quantum states (#/cm^3) over the energy range of (a) $0 \le E \le 2.0$ eV and (b) $1 \le E \le 2.0$ eV. Comment on the results.

Q2.
Plot (writing a piece of Matlab/similar code) the tunneling probability, T as a function of electron energy, E for the conduction electron through a potential barrier of thickness 15 Å and a height equal to 0.3 eV, with the electron *effective* mass of $0.067m_0$ (where $m_0 = 9.8 \times 10^{-31}$ kg is the mass a *free* electron). Vary E from 0 to 4 eV in a step of 0.001eV. Replot the characteristic on the same graph when the barrier thickness is reduced to 5 Å. How can your finding explain the origin of excessive leakage currents as seen in modern nanoscale MOSFETs?
Use: Planck's constant = 6.63×10^{-34} J-s, 1 eV = 1.6×10^{-19} J.