Area: Solid State Devices

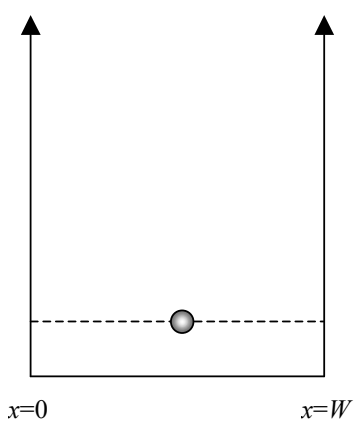
Problem 1

(a) Write down the drift-diffusion equation for electrons, i.e., the total current as a summation of the drift current and the diffusion current terms. (50%)

(b) Show that for a non-degenerate semiconductor, the total current density can be expressed as $J_n = n\mu_n \frac{dF_n}{dx}$, where F_n is the quasi Fermi energy level, n is the electron density, and μ_n is the electron mobility. (50%)

Problem 2:

Consider a particle in a box problem for which the potential is zero at $0 < x < W$ and is infinitely large otherwise. (a) Write down the normalized wave function for the lowest energy level. (70%)



You may find the following equations useful:

$$\sin^2(x) = \frac{1-\cos(2x)}{2} \qquad \cos^2(x) = \frac{1+\cos(2x)}{2}$$

$$e^{ix} = \cos(x) + i\sin(x)$$

(b) Write down the electron density as a function of x in the unit of per length if the lowest energy level is filled by one electron. (30%)