Homework 2

ECE 695-O Semiconductor Transport Theory

Due 2018.10.29

1) For an electron in an S band in a simple cubic crystal in the tight-binding approximation, the band structure has the form

$$\mathcal{E}(\mathbf{k}) = const. - \gamma_0\left(\cos k_x a + \cos k_y a + \cos k_z a\right).$$

Consider an electron moving in an ideally pure such crystal at T=0 (i.e. subject to no scattering), which at time zero(t=0) is described by a wave packet with approximately $\mathbf{k} = 0$ and $\mathbf{r} = 0$. For t>0, there is a constant electric field $\mathbf{E}$ applied along a cube axis. Find the subsequent motion of the electron in real space(i.e. $\mathbf{r}(t)$) and the maximum distance it can travel from the origin, If the band width is 0.06 eV and $|\mathbf{E}| = 1$ mV / cm (millivolt / centimeter).

2) (a) Obtain general expression for the density of states $D_2(\mathcal{E})$in two dimensional system.
(b) Obtain explicit expression for

$D_1(\mathcal{E})$ with $\mathcal{E} = \frac{\hbar^2 k_x^2}{2m_x^*}$ (1D)

$D_2(\mathcal{E})$ with $\mathcal{E} = \frac{\hbar^2 k_x^2}{2m_x^*} + \frac{\hbar^2 k_y^2}{2m_y^*}$ (2D)

$D_3(\mathcal{E})$ with $\mathcal{E} = \frac{\hbar^2 k_x^2}{2m_x^*} + \frac{\hbar^2 k_y^2}{2m_y^*} + \frac{\hbar^2 k_z^2}{2m_z^*}$ (3D)