ECE 656: Fall 2009
Lecture 12 Homework SOLUTION

1) Consider a semiconductor with a slowly varying effective mass, $m^*(x)$. Following the procedure in Lecture 12, derive the equation of motion for an electron in k-space analogous to the result for a constant effective mass.

$$\frac{d(\hbar k_x)}{dt} = F_e = -\frac{dE_C(x)}{dx}$$

HW12 solution

$$E_{TOT} = E_c(x) + \frac{\hbar^2 k^2}{2m^*(x)}$$

$$\frac{dE_{TOT}}{dt} = 0 = \frac{dE_c}{dx}\cdot\frac{dx}{dt} + \frac{\hbar^2 k^2}{2}\frac{d}{dx}\left(\frac{1}{m^*}\right)\frac{dx}{dt}$$

$$+ \frac{dE(k)}{d(\hbar k_x)}\frac{d\hbar k_x}{dt} = 0$$

$$\frac{d(\hbar k_x)}{dt} = -\frac{dE_c}{dx} - \frac{\hbar^2 k^2}{2}\frac{d}{dx}\left(\frac{1}{m^*}\right)$$

$$\frac{d(\hbar k_x)}{dt} = -q\mathcal{E}_x + \frac{\hbar^2 k^2}{2m^*}\frac{1}{m^*}\frac{dm^*}{dx} \quad \checkmark$$