ECE 656: Fall 2009
Lecture 4 Homework
(Revised 8/31/09)

1) For parabolic energy bands, the 2D density of states is

$$D_{2D}(E) = \frac{m^*}{\pi \hbar^2}\Theta(E-\varepsilon_1)$$

Assume a non-parabolic band described by the so-called Kane dispersion,

$$E(k)\left[1+\alpha E(k)\right] = \frac{\hbar^2 k^2}{2m^*(0)}$$

and

1a) derive the density of states

1b) use a figure to explain why the DOS changes from the parabolic case

2) For a nonparabolic energy band described by the Kane dispersion, derive the corresponding $M(E)$

HW 4

1a) $N_k dk = D(E) dE$

$$2 \times \frac{2\pi k dk}{4\pi^2} = D(E) dE$$

$$D(E) = \frac{1}{\pi} k dk/dE$$

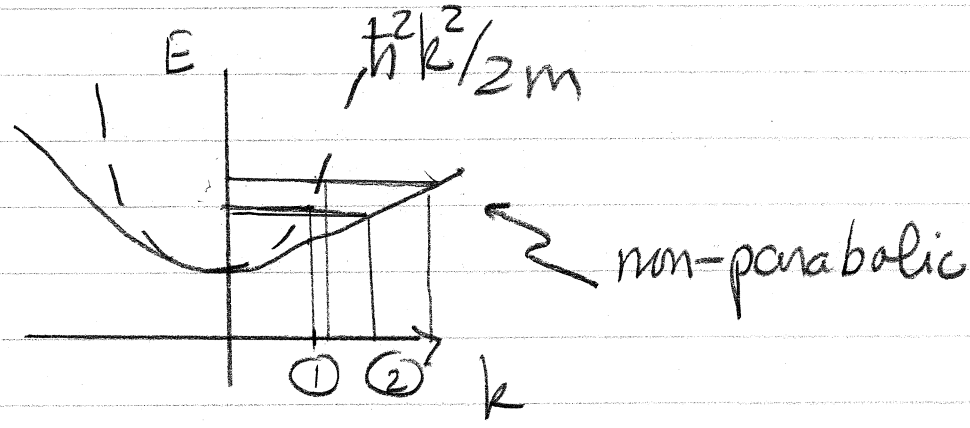
$$D(E) = \frac{m^*(0)}{\pi \hbar^2}(1+2\alpha E)$$

$$E + \alpha E^2 = \hbar^2 k^2/2m^*$$

$$\frac{dE}{dk}(1+2\alpha E) = \frac{\hbar^2}{m^*} k$$

$$\frac{k dk}{dE} = \frac{m}{\hbar^2}(1+2\alpha E)$$

(1b)



any given range of energy, dE, will map into a larger range of k (① vs. ② above) and, therefore, contain more states.

1)

HW4

$$M(E) = \frac{W}{\lambda_B(E)/2} \qquad (1)$$

$$E(1+\alpha E) = \hbar^2 k^2 / 2m^*(0)$$

$$k = \frac{\sqrt{2m^* E(1+\alpha E)}}{\hbar} = \frac{2\pi}{\lambda_B} = \frac{\pi}{\lambda/2}$$

$$\frac{1}{\lambda_B/2} = \frac{\sqrt{2m^* E(1+\alpha E)}}{\pi\hbar}$$

use in (1)

$$M(E) = \frac{W\sqrt{2m^* E(1+\alpha E)}}{\pi\hbar} \checkmark$$