Homework F

Instructor: Yoonseok Lee

Submit only HW's. EX's are additional problems that I encourage you to work on.

(**a**.**b**) means problem number **b** of chapter **a** in *Introduction to Solid State Physics* (8th ed.) by Kittel.

Use SI unit.

Due March 13

HW 1: (8.1) (10 pt)

HW 2: (8.2) (10 pt)

HW 3: (8.3) (10 pt)

HW 4: (8.4) *Solve this as a special case of the following problem.* In general, the reciprocal effective masses of electrons in anisotropic bands are represented using tensors:

$$(\mathbf{M}^{-1})_{ij} = \frac{1}{\hbar^2}\frac{\partial^2 E}{\partial k_i \partial k_j}.$$

(a) The reciprocal effective mass tensor is given by

$$\mathbf{M}^{-1} = \begin{pmatrix} \frac{1}{m_1} & 0 & 0 \\ 0 & \frac{1}{m_2} & 0 \\ 0 & 0 & \frac{1}{m_3} \end{pmatrix},$$

when a particular set of x, y, and z axes are chosen. Assuming that m_i is constant, sketch the constant energy surface.

(b) One can easily show that

$$\mathbf{M} = \begin{pmatrix} m_1 & 0 & 0 \\ 0 & m_2 & 0 \\ 0 & 0 & m_3 \end{pmatrix}.$$

(No need to prove this.)
A magnetic field $\vec{B}$ is applied in an arbitrary direction. Using the following matrix equation with $\vec{v} = \vec{v}_o e^{i\omega t}$:

$$\mathbf{M}\frac{d\vec{v}}{dt} = -e(\vec{v} \times \vec{B}),$$

show that $\omega = \frac{eB}{m^*}$ (*cyclotron frequency*) with

$$m^* = \left(\frac{m_1 m_2 m_3 B^2}{m_1 B_x^2 + m_2 B_y^2 + m_3 B_z^2} \right)^{\frac{1}{2}}.$$