I. PROBLEM SESSION 11

A. Problem 11.1

-What is the definition, and the physical meaning of the fermi surface?
-What is the difference between the reduced Brillouin zone and the reduced zone scheme?
-Describe how the Fermi surface is constructed in the case of a small amplitude periodic potential. Use the square lattice as an example. Make a sketch and show the Fermi surfaces for such a lattice in the two lowest brillouin zones.
-Discuss the concept of orbits. What is the difference between electon, hole and open orbits?
-How is electronic orbits modified in the presence of external magnetic field? Describe the phenomenon of quantization of electron orbits.
-Can you describe any experimental methods used for investigation of Fermi surfaces?

B. Problem 11.2

This question is intended to help you understand the way in which real bands are plotted. It shows that in even quite a simple situation, a diagram which is at first sight rather daunting can result! Fig. 1 shows a plan view of the Brillouin zone of a square lattice, with some points of high symmetry labelled. Sketch the energies of the free electron bands $E = (\hbar(\vec{k} - \vec{G})^2)/(2m_e)$ up to $E = 10h^2/8m_e a^2$ as k traverses the path $\Gamma - M - X - \Gamma$ along the straight lines shown. You will need to consider dispersion curves originating from several neighbouring Brillouin zones. It will become evident that dispersion curves converge at points of high symmetry; label the degeneracy, i.e the number of curves that converge, at such places on your diagram.

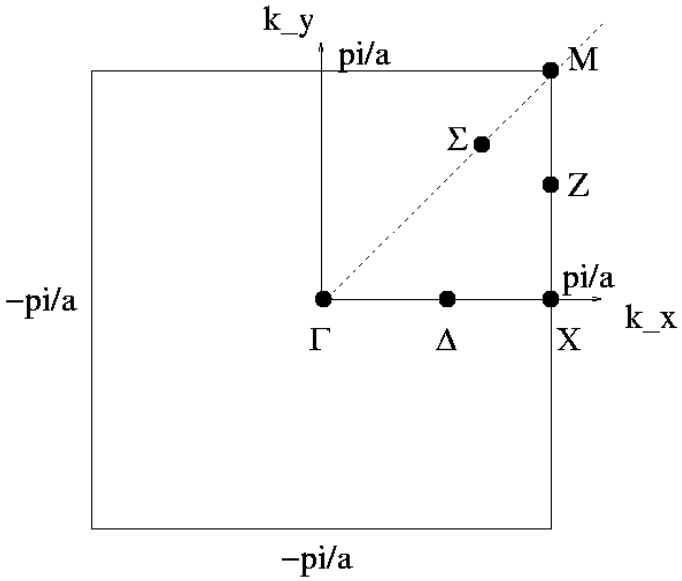

Figure 1: A plan view of the brillouin zone of a square lattice, with some points of high symmetry labeled.

C. Problem 11.3

Brilloin zones of rectangular lattice. Make a plot of the first two Brilloin zones of a primitive rectangular two-dimensional lattice with axes $a, b = 3a$.

D. Problem 11.4

Brillouin zone, rectangular lattice. A two-dimensional metal has one atom of valency one in a simple rectangular primitive cell $a = 2\mathring{A}; b = 4\mathring{A}$ a) Draw the first Brillouin zone. Give its dimensions in cm^{-1}. b) Calculate the radius

of the free electron Fermi sphere, in cm^{-1}. c) Draw this sphere to scale on a drawing of the first Brillouin zone. Make another sketch to show the first few periods of the free electron band in the periodic zone scheme, for both first and second energy bands. Assume there is a small energy gap at the zone boundary.

E. Repetition

Please ask questions from unclear points in the curriculum, lectures or previous exercises.