I. PROBLEM SESSION 13

A. Problem 13.1

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

B. Problem 13.2

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.

C. Problem 13.3

Hexagonal close packed structure. Consider the first Brillouin zone of a crystal with simple hexagonal lattice in three dimensions with lattice constants a and c. Let $\vec{G}_c$ denote the shortest reciprocal lattice vector parallell to the c axis of the crystal lattice. a) Show that for a hexagonal-close packed crystal structure the Fourier component $U(\vec{G}_c)$ of the crystal potential $U(\vec{r})$ is zero. b) Is $U(2\vec{G}_c)$ also zero? c) Why is it possible in principle to obtain an insulator made up of divalent atoms at the lattice points of a simple hexagonal lattice? d) Why is it not possible to obtain an insulator made up of monovalent atoms in a hexagonal-close-packed structure.