I. PROBLEM SESSION 10

A. Problem 10.1

-Describe the Kronig-Penney model and formulate the central equation for this model. How does it look in the center and at the edge of the Brillouin zone?
-Recall the wave equation for a particle in a periodic potential. What happens to this equation at the boundary of the Brillouin zone?
-How are energy bands filled? What is the difference between a metal, semi-metal, semiconductor and insulator.

B. Problem 10.2

Kronig-Penney model:
a)For the delta-function potential with $P << 1$, find at $k = 0$ the energy of the lowest energy band. Here P is the parameter of the model (see Eq. 21 a,b in Kittel)

$$P = lim_{b\to 0, U_0\to\infty} mU_0ba/\hbar^2 \tag{1}$$

b) What implications might the result of b) have on the conductivity of divalent metals?For the same problem, find the band gap at $k = \frac{\pi}{a}$

C. Problem 10.3

This question is intended to help you understand the way in which real bands are plotted in later chapters. 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 $10h^2/8m_ea^2$ 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.

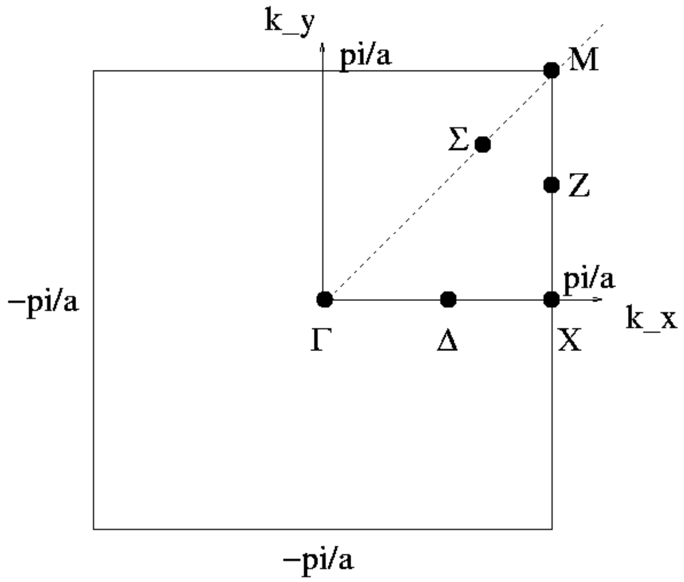

Figure 1: A plan view of the brillouin zone of a square lattice, with some points of high symmetry labeled.