Solid State Physics

(Instructor: AKB, Department of Physics, Asutosh College)

Assignment III: Band Theory

Submission due date: 20/01/2021

Q.1) Show that **(a)** the number of possible wave functions in any energy band is equal to the number of unit cells, and **(b)** a band can accomodate 2N electrons, where N is the number of atoms in the crystal.

Q.2) **(a)** The potential of an electron in a one dimensional lattice is of the same type as that used in the Kronig-Penney model for the delta-function potential. In the limit $V_0 ab << \hbar^2/m$, find at $k = 0$ the energy of the lowest energy band. **(b)** For the same problem show that the band gap at $k = \frac{\pi}{a}$ is $2V_0\frac{b}{a}$. **(c)** Also, show that the energy of the lowest energy band is $E = \frac{\hbar^2 P}{ma^2}$.

Q.3) **(a)** Show for a square lattice (in two dimensions) that the kinetic energy of a free electron at a corner of the first zone is higher than that of an electron at the midpoint of a side face of the zone by a factor of 2. **(b)** What is the corresponding factor for a simple cubic lattice (in three dimensions)? **(c)** What bearing might the earlier obtained result have on the conductivity of divalent metals?