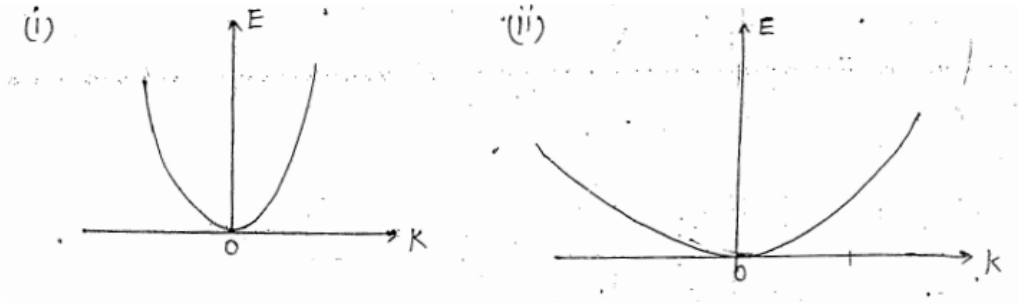
Tutorial 11, Physics-2 (15B11PH211), Even Semeseter-2022

1. What do you mean by Brillouin Zones? What does the boundaries of Brillouin Zones represent? Construct the Brillouin Zones for a simple square lattice of side "a". **[CO2]**
2. Show that the kinetic energy of a free electron at a corner of the first Brillouin zone of a two-dimensional square lattice is two times than that of an electron at the mid-point of a side of the zone. **[CO3]**
3. What do you mean by effective mass of an electron in crystal? Explain the concept of positive and negative mass of an electron with the help of E-k curve. **[CO3]**
4. Distinguish between the band structure of a Semiconductor, Metal and Insulator. **[CO2]**
5. Given below are the E-k curve for two different materials. In which case the effective mass of an electron is higher? **[CO2]**



6. Suppose that E-k relation in one dimensional direct band gap crystal is given by E (k) = E1 + E1$\sin^2$ (ka/2); where 'a' is the crystal constant and E1 is constant. (a) Calculate the effective mass of an electron at bottom of conduction band (Plot between E-k is to be used), and at k=$\pm\pi$/a (b) velocity of electron at k=0 and k = 2π/a. **[CO3]**
7. The energy of an electron in a band as a function of its wave vector k is given by E(k)=E_0-B($\cos k_x a+\cos k_y a+\cos k_z a$), where E_0, B and a are constant. Calculate the effective mass of an electron near the bottom of the band. **[CO3]**