

MINOR-I (Feb 1, 2017)
Solid State Physics (PYL 114)

Time: ~~55~~ minutes (4:15 – 5:10 pm)

Max. Marks: 20

Note : 1. Attempt all the questions.

2. Use of mobile phone is **STRICTLY PROHIBITED.**

1. (a) Write down the primitive basis vectors (a , b , & c) of the primitive unit-cell of a fcc lattice.
(b) Using above, show that the reciprocal lattice of a fcc lattice is a bcc direct lattice. 1+4

2. A hypothetical element belongs to the base centered tetragonal (bct) lattice class with only two atoms of same kind (having atomic scattering factor f) located at A $(0,0,0)$ and B $(\frac{1}{2}, \frac{1}{2}, 0)$, and have the lattice parameters $a=2\text{\AA}$ and $c=3\text{\AA}$.
(a) Obtain the simplified expression of F^2 , where F is the structure factor.
(b) From this find the condition(s) for allowed and forbidden diffractions in terms of (hkl) .
(c) Determine the positions (2θ) of the first four diffraction lines that would be observed on a powder pattern recorded with $\text{Cu-}K_\alpha$ radiation ($\lambda=1.54 \text{\AA}$). 3+1+2

3. (a) Pointwise discuss the scheme used for construction the Ewald's Sphere. How does the concept of Ewald's Sphere help in analyzing the diffraction pattern of a crystal?
(b) Why we need to invoke the concept of "Limiting sphere" in context to reciprocal lattice (Is the concept of Ewald's sphere not sufficient)? 3+1

4. Sketch a typical E -vs.- k and v -vs.- k curves (E =energy, v =velocity, and k =wave vector) as expected for the electron moving inside a solid which is approximated as a periodic array of 1D, square well potentials (no description). Obtain an expression for the effective mass of the electron in such a case. Using this expression briefly discuss the changes in the electron's effective mass within the first Brillouin zone.5