Roll Number: …….

Unique Paper code **: 32221502**

Name of the Paper **: Solid State Physics**

Name of the course **: B.Sc. Hons.–CBCS_Core**

Semester **: V**

Duration: 3 Hours Maximum Marks: 75

Answer any four questions. All the questions carry equal marks.

Q.1: How the Brillouin Zone associated to reciprocal vectors of any structure? Assuming hexagonal translation lattice vectors are $a_1 = \frac{\sqrt{3}}{2}\hat{\imath} + \frac{a}{2}\hat{\jmath}$, $a_2 = -\frac{\sqrt{3}}{2}\hat{\imath} + \frac{a}{2}\hat{\jmath}$, $a_3 = a\hat{k}$. Calculate the dimensions first Brillouin Zone for the Hexagonal lattice. (8.75+10)

Q.2: How phonons can be generated? Why is diamond a good of heat conductor like metals but a bad conductor of electricity unlike metals? Does the observed shift in photonic frequency agree with theoretical value? What are the fundamental assumptions in Debye's theory of lattice specific heat of solids?

(2+4+6+6.75)

Q.3: The energy wave vector dispersion relation for one dimensional crystal of lattice constant a is given by $E(k)=E_o-\alpha-2\beta\cos ka$, where E_o, α, β are the constants. Obtain the effective mass of the electron at the bottom and at the top of the band. What is the concept of effective mass of electron and hole (give your separate comments)? (10+4.25+4.5)

Q.4: Explain the formation of ferromagnetic domains. The magnetic susceptibility of silicon is -0.4×10^{-5}. Calculate the flux density and magnetic moment per unit volume when magnetic field of intensity 5×10^5 *A/m* is applied. ($\mu_o=4\pi \times 10^{-7}$). Explain that why Wiess molecular constant /Wiess factor have different values for ferro-magnetics? (6+8+4.75)

Q.5: Derive expression for polarizability assuming that 1D diatomic ionic solid (NaCl) subjected to an alternating electric field $E=E_L e^{-i\omega t}$. The dielectric constant of Si is 12. The length of the edge of its unit cell is 54.3 nm. Find the polarizability of Si atom. ($\varepsilon_o=8.854X10^{-12}$ F/m^3).

(10+8.75)

Q.6: What are the London equations? Prove that susceptibility of superconductor is -1 and relative permeability is zero**.** Drive London equation for the absence of resistance. Find the critical current which can pass through a long thin superconducting wire of aluminum of diameter 2 mm, the critical magnetic field for aluminum is 7.9×10^3 A m^{-1}. (2+8+4+2.75)