QP Code : 75565

(3 Hours) [Total Marks: 75

N.B.: (1) **All** questions are **compulsory.**
(2) **Figures** to the **right** indicate **maximum** marks.
(3) Answers to the two sections must be written in the **same** answer-book.

Section I

(Solid State Physics)

1. Explain the Wigner Seitz method for calculation of energy bands in crystals. 12

OR

2. (a) Define Bragg's law in X – ray diffraction and explain how different diffraction peaks are obtained using monochromatic x – rays in a single crystal. 06

(b) Explain the concept of (i) a reciprocal lattice (ii) Brillouin Zone 06

3. Write notes on any **two** of the following:- 13

(a) Einstein model for specific heat of solids.

(b) Role of crystal imperfection in thermal conductivity.

(c) Anharmonic crystal interaction.

OR

4. Obtain dispersion relation for a diatomic linear chain of atoms with masses m and M. Explain clearly any approximations used with the help of suitable diagram, illustrate the optical and acoustic branches with their limiting frequencies. 13

5. (a) Find the Lande 'g' factor for a Pr ion in its ground state with two 'f' electrons. Then compute the effective number of Bohr magnetons for Pr ion. 06

(b) What is free ion paramagnetism ? Explain the importance of Hund's rules in determining the magnetic moment associated with each ion. 07

OR

6. Discuss D.C. and A.C. Josephson effect and explain their importance. 13

SECTION II

(QUANTUM MECHANICS II)

7. (a) Find the following commutators:

1] $[\widehat{x^2},\widehat{p^2}]$, where p is the momentum operator. 3

2] $[\widehat{L_x},\widehat{L_y}]$, where $\hat{L}$ is an angular momentum operator. 3

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(b) Show that in spherical coordinates 6

$$L_z = -i\hbar\frac{\partial}{\partial\phi}$$

OR

8. (a) Estimate the energy of an electron confined within the nucleus of radius 10^{-13} cm. Given that the electrons in the β decay have the energies ~ 15 MeV, what does it say about the possibility of electron being nuclear constituent? (1 eV = 1.6 X 10^{-12} ergs). 4

(b) Find the commutators:

(i) $[\widehat{L^2}, \widehat{L_y}]$, where $\hat{L}$ is an angular momentum operator. 3

(ii) $[f(x), \hat{p}]$, where $f(x)$ is some function of x and $\hat{p}$ is momentum operator. 2

(iii) State the general uncertainty relation between two 2 Hermitian operators $\hat{A}$ and $\hat{B}$. From that, show, $\Delta x\, \Delta E \geq \frac{\hbar}{2m}|\langle p_x\rangle|$ 3

9. For the hydrogen atom set up the radial Schrodinger equation for the bound state radial wave function. R(r). Also show that 12

$\frac{d^2u}{d\rho^2} - \frac{l(l+1)}{\rho^2}u + \left(\frac{\lambda}{\rho} - \frac{1}{4}\right)u = 0$, where $u(r) = rR(r)$.

OR

10. Derive an expression for the second order correction to theeigenfunction in time independent non degenerate perturbation theory. 12

11. (a) Obtain the relationship between scattering angle and cross section in Laboratory and center of mass frame. 7

(b) Apply Born approximation to obtain differential scattering cross section for exponential potential $V(r) = -V_0 e^{-r/a}$, where V_0, and a are constants characterizing strength and range of the potential. 6

12. (a) Show that the scattering amplitude in Born Approximation is

$$f(\theta) = -\frac{2m}{\hbar^2 K}\int_0^\infty r\, V(r) \sin Kr\, dr\, \vec{K} = \vec{k} - \vec{k'}$$ 7

(b) State and prove Optical Theorem. 6

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