Q.P.Code: 26927

(3 Hours) [Total Marks:75

N.B. **(1)** Answers to the **TWO** sections should be written in the **SAME** Answer book.

(2) Figures to the right indicate full marks.

(3) Use of non – programmable calculators / log tables is allowed.

(4) Symbols have their usual meaning unless otherwise stated.

SECTION I

(SOLID STATE PHYSICS)

1		Describe the Tight Binding Approximation of calculating energy bands in a crystal.	**13**
		OR	
2	(a)	State the expressions of atomic form factor ‘f’ and the structure factor ‘F’. Also explain their concept and physical significance in X-ray diffraction.	**07**
	(b)	Discuss the temperature dependence of the intensity of Bragg reflected X-ray lines.	**06**
3		Write notes on the following	**12**
	(a)	Role of crystal imperfection in thermal conductivity.	
	(b)	Anharmonic crystal interaction.	
		OR	
4		Describe the vibrational modes of a diatomic linear chain with the help of neat diagram. Derive the dispersion relation for the diatomic linear chain.	**12**
5	(a)	Write a note on Cooling by adiabatic demagnetization.	**06**
	(b)	Describe the following magnetic ordering using suitable diagrams: i)Ferromagnetic order, ii) Antiferromagnetic order, iii) Ferrimagnetic order.	**06**
		OR	
6		Write notes on any **two** of the following:-	**12**
	(a)	Coercive force and hysteresis.	
	(b)	Qualitative explanation of BCS theory.	
	(c)	High T_C superconductors.	

SECTION II

(Quantum Mechanics II)

7 (a) Initially a free particle is represented by a wave function **6**

$\Psi(x,0) = A(a+x)(a-x) \quad for\ -a \leq x \leq a$

$= 0 \quad otherwise.$

1] Calculate <x>, <p>, <x^2>, <p^2> and <H>

2] Find the uncertainty product $\Delta x\ \Delta p_x$

(b) Write down Schrodinger's time dependent equation. From that derive the continuity equation: $\frac{\partial \rho}{\partial t} + \nabla \cdot J = 0$ **6**

Identify the expression for the current. Evaluate $\vec{J}$ for $\psi(r) = e^{i\vec{k}\cdot\vec{r}}$

OR

8 (a) Show that the momentum operator is Hermitian. **12**

i. e. $p_x = -i\hbar\frac{\partial}{\partial x}$ is Hermitian operator.

(b) Consider the operator matrix, $A = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$

1] Is A hermitian?

2] Find its eigenvalues.

3] Obtain the eigenvectors and normalize them.

9 (a) The initial state of the Gaussian wave packet is: **13**

$\Psi(x,t=0) = \frac{1}{\sqrt{a}\ (2\pi)^{1/4}} e^{ik_0x} e^{-x^2/4a^2}$

1] Find the momentum amplitudes for this state?

2] What is the momentum probability density?

Use $\int_{-\infty}^{\infty} e^{-\alpha x^2 + \beta x} dx = \sqrt{\frac{\pi}{\alpha}} e^{\beta^2/4\alpha}$

(b) 1] Define Hermitian adjoint and Hermitian operator.

2] Show that the momentum operator is Hermitian.

3] Find the normalized eigenfunction of the momentum operators.

OR

10 (a) Initially a free particle is represented by a wave function **13**

$\Psi(x,0) = A(a+x)(a-x) \quad for\ -a \leq x \leq a$
$= 0 \quad otherwise.$

1] Calculate <x>, <p>, <x^2>, <p^2> and <H>

2] Find the uncertainty product $\Delta x \, \Delta p_x$

(b) Consider a particle in an finite potential well given by:

V(x) = 0 for x < 0 and x > a

= -V_0 for 0 < x < a

1] Set up the Schrodinger equation in different region and solve.

2] Obtain the transcendental equation and calculate energy eigenvalues from them.

3] Sketch the ground state and the first excited state eigenfunctions.

11 (a) For an harmonic oscillator **13**

1] Define an annihilation operator, obtain the normalized ground state wave function using it.

2] find the expression for the remaining wave functions using creation Operators.

(b) A particle moving along positive x direction experiences a potential given by:

V(x) = 0 for x<0

= - V_0 for x>0.

Define and calculate

1] Reflection coefficient

2] Transmission coefficient

OR

12 (a) Write down Schrodinger's time dependent equation. From that derive the continuity equation: **13**

$$\frac{\partial \rho}{\partial t} + \nabla \cdot J = 0$$

Identify the expression for the current. Evaluate $\vec{J}$ for $\psi(r) = e^{i\vec{k}\cdot\vec{r}}$

(b) Show that $[x, p_x] = i\hbar$.

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