This question paper contains **4** printed pages.]

Your Roll No. .....

1399

B.Sc. (Hons.) / II A

ELECTRONIC SCIENCE – Paper – 2.1 (VIII)

(Modern Physics and Quantum Mechanics)

Time : 3 Hours **Maximum Marks : 38**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt **five** questions in all including Question No. 1 which is compulsory.

1. (a) Is an electron a particle ? Is it a wave ? Explain. 10

   (b) What is the difference between L-S and J-J coupling ?

   (c) State neutrino hypothesis of β-decay.

   (d) How much energy is required to remove an electron from a hydrogen atom in a state with N = 8 ?

   (e) List similarities and differences between phonons and photons.

2. Writing Schrodinger equation for linear harmonic oscillator.

(a) Obtain Zero-point energy.

(b) Write first five energy levels and spacing between them.

(c) Obtain Wave function. $\left(4, 1\frac{1}{2}, 1\frac{1}{2}\right)$

3. (a) A particle of mass m is confined in a field free region between impenetrable walls at $x = 0$ and $x = L$ in one dimension. Show that stationary energy levels of the particle are given by

$$En = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$$

Obtain the corresponding normalised wave functions.

(b) Obtain the expectation value of position and momentum for a particle in a box.

(c) Determine the Eigen value of a state $\psi = e^{4x}$ when it was operated by an operator $\frac{d^2}{dx^2}$. **3, 3, 1**

4. (a) Discuss the De Broglie's hypothesis for material particle and give in detail the Davission and Germer experiment in support of above hypothesis.

(b) The first order Bragg maximum of electron diffraction in a mixed crystal (d = 0.9086 Å) occurred at a glancing angle of 65°. Calculate the De Broglie wavelength of the electron. **2, 3, 2**

5. (a) Derive the relation

$\Delta E = m, g; \mu_B \cdot B$ for anomalous Zeeman effect where symbols have their usual meanings.

(b) What are differences between normal and anomalous Zeeman effect ?

(c) The D_1 and D_2 lines of sodium are known to arise from the transitions from the $2^2 p\frac{1}{2}$ to $2^2 S\frac{1}{2}$ state and from $2^2 P\frac{3}{2}$ to $2^2 S\frac{1}{2}$ state respectively. Find the number of possible Zeeman components of each of these lines in magnetic field. **2, 1, 4**

6. (a) A substance A, with transformation constant λ_1, transforms directly into B with constant λ_2. If at time t = 0, there are N atoms of A and none of B present, obtain an expression for the number of B atoms present at any later time t. Find also the value for which the amount B is maximum.

(b) The half life of radon is 3.8 days. After how many days will only $\frac{1}{2}^{th}$ of radon sample be left over ? **5, 2**

7. (a) Explain Thomson's parabola method for comparing the masses of two different kind of atoms.

(b) In a positive ray apparatus a singly ionized particle and a doubly ionized particle form identical parabolas when the magnetic flux densities are 0.75 tesla and 1.5 tesla respectively, while electric field is kept the same. Compare their masses. **5, 2**
