Gurudas College
B. Sc. Semester - 5 (Internal Assessment)
Subject: CEMA (CC-5-11)

Time: 30 Mins. **Full Marks: 10**

Answer any 5 questions.

1. For simple harmonic oscillator the ground state wave-function is [2]

$$\psi_0 = \left(\frac{\alpha}{\pi}\right)^{1/4} \exp\left(-\frac{1}{2}\alpha x^2\right),$$

Find $\langle x \rangle$.

2. Show that $\left[\hat{L}^2, \hat{L}_x\right] = 0$. [2]

3. Differential volume element in spherical polar co-ordinate is, [2]

$$dV = r^2 \sin\theta dr d\theta d\phi,$$

calculate volume of a sphere for $r = a$.

4. Show that method of central difference is better approximation for numerical differentiation as compared to forward or backward difference. [2]

5. (a) What is an ensemble? [1]
   (b) Write down the value of zero point vibrational energy of a molecule clearly mentioning the terms involved in it. [1]

6. (a) What is partition function? [1]
   (b) Write down the mathematical expression of heat capacity at constant volume in terms of partition function. [1]

7. (a) What type of substance is used in cooling by adiabatic demagnetization? Name one such substance. [1]
   (b) What do you mean by adiabatic demagnetization? [1]

8. (a) Draw the qualitative graphs of entropy vs. temperature of a paramagnetic substance with magnetic field & without magnetic field. [1]
   (b) For the quadratic equation $x^2 - 5x + 6 = 0$, if the initial guess is 3.2, then predict the root using Newton-Raphson method. [1]