

M.Sc. (Physics) (CBCS Pattern) Sem-III  
**PSCPHYT09 - Core Paper-IX - Quantum Mechanics-II**

P. Pages : 2

Time : Three Hours



**GUG/W/22/11295**

Max. Marks : 80

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Either:

1. a) Define degenerate states. How perturbation theory is applied to ground energy state. 8
- b) Calculate the first order energy correction for an-harmonic oscillator. 8

**OR**

- e) Explain normal and anomalous Zeeman effect with neat diagram. 8
- f) Define stark effect. Explain first order stark effect in the ground and first excited state of H-atom. 8

Either:

2. a) Explain transition rate in time dependent perturbation in radiative transitions. 8
- b) Discuss time dependent perturbation theory and derive the expression of Fermi-Golden rule of probability transition. 8

**OR**

- e) What is W.K.B. approximation? Discuss the conditions of applicability of the W.K.B. approximation. 8
- f) Explain variational principle in ground state of He-atom. 8

Either:

3. a) Explain scattering theory of quantum particle using partial wave analysis. 8
- b) Explain Heitler – London theory of the hydrogen molecule. 8

**OR**

- e) What is resonance scattering? Discuss the expression for the scattering cross-section at the resonance. 8
- f) Discuss scattering cross-section in laboratory and centre of mass system. 8

Either:

4. a) Derive Klein Gordon relativistic equation for a free particle. 8
- b) Explain spin-orbit interaction for Dirac's particles. 8

**OR**

e) Prove that Dirac's electron has a magnetic dipole moment. 8

$$\vec{\mu} = \frac{e \cdot \hbar \cdot \vec{r}}{2 \cdot m \cdot c}$$

f) Define Dirac Hamiltonian for the relativistic particle. What are the properties of  $\alpha$  and  $\beta$ . 8

5. Answer all the followings:

a) Explain second order stark effect in an harmonic oscillator. 4

b) What are Einstein's A and B coefficients? Give their relation. 4

c) Explain 'Ortho' and 'Para' states of the helium atom. 4

d) Give the physical significance of negative energy states. 4

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