

Reg. No..... Name.....

**M.SC DEGREE END SEMESTER EXAMINATION OCTOBER 2016****SEMESTER - 3: PHYSICS****COURSE: P3PHYT09 - QUANTUM MECHANICS - II**

Common for Regular (2015 Admission) &amp; Supplementary / Improvement (2014 Admission)

Time: Three Hours

Max. Marks: 75

**Part A (Objective)**(Answer **all** questions. Each question carries 1 Mark.)

- Probability density associated with Dirac equation is  
(a)  $\Psi^i\Psi$  (b)  $c\Psi^+ \alpha\Psi$  (c)  $c\dot{\psi}$  (d) none of the above
- If  $L_x$  is the x component of orbital angular momentum of the Dirac particle then  $\frac{dL_x}{dt}$  is  
(a)  $c[\alpha_y P_z - \alpha_z P_y]$  (b)  $c[\alpha_z P_y - \alpha_y P_z]$  (c)  $c[y P_z - z P_y]$  (d) none of the above
- $(\sigma' \cdot L)(\sigma' \cdot L)$  is  
(a)  $L^2 - i(\sigma' \cdot L)$  (b)  $L^2 + i(\sigma' \cdot L)$  (c)  $L^2 + 1/2\hbar\sigma'$  (d)  $L^2 - 1/2\hbar\sigma'$
- Example of scalar field is  
(a) K G Field. (b) Dirac field (c) EM field (d) Schrodinger field.
- $\gamma_\mu\gamma_\nu - \gamma_\nu\gamma_\mu$  is , where  $\mu, \nu = 1, 2, 3, 4$   
(a) 0 (b) 1 (c)  $2\delta_{\mu\nu}$  (d)  $4\delta_{\mu\nu}$   
(1 x 5 = 5)

**Part B (short Answers)**(Answer **any Five** questions. Each question carries 2 Marks)

- Describe the operation of time evolution operator.
- What are partial waves?
- State the meaning of resonance scattering.
- What is meant by large and small components?
- Explain why orbital angular momentum alone is not conserved in Dirac theory.

11. The dimension of Dirac matrices has to be even. Why?
12. Distinguish between function and functional.
13. State Noethers theorem.

(2 x 5 = 10)

### **Part C (Problem/short Essay)**

(Answer **any three** questions. Each question carries 4 Marks.)

14. Explain the interaction picture in quantum mechanics and obtain equation of motion in that picture.
15. Explain low energy scattering when the potential is repulsive and attractive.
16. Describe the existence of particle and antiparticle states by the operation of charge conjugation.
17. What are bilinear covariants? Explain them and obtain an expression for current density.
18. Distinguish between second quantization of bosons and fermions.

(4 x 3 = 12)

### **Part D (Essay)**

(Answer **all** questions. Each questions carries 12 Marks)

19. (a) Explain the interaction of an atom with electromagnetic field using time dependent perturbation theory.

OR

- (b) Explain the theories of (i) adiabatic and (ii) sudden approximation with example.

20. (a) Explain the theory of Born approximation and deduce its condition of validity.

OR

- (b) Obtain the expression for differential scattering cross-section when the energy of the incident particle is small compared to energy of the scattering centre.

21. (a) From Dirac equation obtain Pauli's equation for an electron.

OR

- (b) Derive the expression for the 4 - vector probability density and equation of continuity (i) of Dirac particle (ii) of K G particle.

22. (a) Discuss the quantization of non relativistic field. Obtain the expression for Hamiltonian. Show that anticommutation relations are necessary for fermions.

OR

(b) Show the method of obtaining the quantized form of Hamiltonian in the Dirac field. Discuss the result.

(12 x 4 = 48)

\*\*\*\*\*