

**ZA-111**

April-2014

M.Sc., Sem.-IV

**PHY-507 : Physics (Nuclear Physics & Advanced Quantum Mechanics-II)**

Time : 3 Hours]

[Max. Marks : 70

- Instructions :** (1) Attempt **all** questions.  
 (2) Symbols and terminology have their usual meanings.

1. (A) Explain the square well potentials with infinite depth. 7

**OR**

Explain the magnetic moment of nuclei and sketch the magnetic dipole moments against the I.

- (B) What is resonance ? Discuss in detail on Breit – Wigner dispersion formula for  $\Gamma = 0$ . 7

**OR**

Discuss : Spin orbit potential.

2. (A) Differentiate the elementary particles in terms of spin and discuss fundamental interactions in detail. 7

**OR**

State the CPT theorem. Discuss the Parity in detail.

- (B) Explain how product of charge conjugate and parity violates in the decay of K-meson ? 7

**OR**

Write short note on G-parity.

3. (A) For  $j = 1$ , find out the values of matrix elements of  $J^2$  and  $J_z$ . Also find the values of matrix elements  $J_+$  and  $J_-$ . 7

**OR**

Find out the values of (1)  $[L^2, L_x]$  (2) if  $\vec{L} = \vec{r} \times \vec{P}$  then find out the value of  $L^2$  in spherical polar co-ordinates.

- (B) For  $s = 1/2$ , define basis states and show that  $\vec{S} = \frac{1}{2} \hbar \vec{\sigma}$ . 7

**OR**

What is the wave function for  $S = 1/2$ , if the spin component in the direction of the unit vector  $\hat{n}$  has value  $\frac{1}{2} \hbar$  ?

4. (A) Derive the Klein-Gordon equation and show that it is for a spin zero particle. Show that the K.G. equation can not explain the probability density. 7

**OR**

State the limitations of Klein-Gordon equation. Obtain Dirac equation and explain the physical significance of negative energy states.

- (B) Show that the Dirac matrices must be even dimensional. Calculate the charge density and current density for a free Dirac electron. 7

**OR**

Consider a relativistic Dirac electron placed in a magnetic field. Write the energy eigen value equation and solve it to obtain the spin magnetic moment.

5. Short answer : 14

- (1) In shell model, for even-even nuclei have total ground state angular momentum  $I = 0^+$ . (True / False)
- (2) Define isoscalar and isovector mode in vibrational states in collective model.
- (3) Shell model is capable of explaining not only magic numbers but also \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ nuclear properties.
- (4) In case of harmonic potential the total maximum number of particles for all levels upto  $\wedge_{\max}$  is given by  $N_{\max} = \text{_____}$ .
- (5) If  $\eta_1 = -1$ , then reaction scattering cross section is  $\sigma_r = \text{_____}$  and scattering takes place \_\_\_\_\_ reaction.
- (6) What do you mean by capture process ?
- (7) In case of particle with spin, write the equation for the scattering cross section  $\sigma^{(1)}(x, y) = \text{_____}$ .
- (8) What will be the value of  $J_+^2$  ?
- (9) What will be the eigen states of  $S^2$  and  $S_z$  ?
- (10) What will be the result of J- on eigen states of  $|J + 1, m - 1\rangle$  ?
- (11) If  $n = 3$  then what will be the possible values of  $m$  ?
- (12) State  $[L_z, H] \neq 0$ .
- (13) What is Bohr magneton ?
- (14) What are the essential constraints ?

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