Seat No. : _____

XX-134

April -2013

M.Sc. Sem.IV

507-PHYSICS

Nuclear Physics II & Advanced Quantum Mechanics II

Time : 3 Hours] **[Max. Marks : 70**

1. (a) Obtain the cross section for the formation of the compound nucleus by S-wave neutrons. **7**

OR

What are called resonance in nuclear reactions ? Explain Briet-Wigner dispersion formula for I = 0.

(b) Discuss : Magnetic moments in the shell model predictions. **7**

OR

Explain continuum theory of nuclear reactions.

2. (a) Show the classification of particles in terms of its spin and explain interaction forces between the particles in details. **7**

OR

Discuss : Parity and Time reversal of elementary particles.

(b) Write the properties of elementary particles. **7**

(i) Mass less BOSONS

(ii) LEPTONS

OR

Discuss in details about the K-Mesons with necessary properties and reactions.

3. (a) Derive the matrix elements of $J_+ = J_x + iJ_y$ and $J- = J_x - iJ_y$ with respect to the basis in which J^2 and J_z are diagonal. Show that every matrix representative of a component of J which satisfies J x J = iħ J has non zero trace. **7**

OR

If J_x, J_y and J_z are angular momentum operators, show that $[J^2, J\pm] = 0$, $[J_+,J_-] 2\hbar J_z$ where, $J_+ = J_x + iJ_y$ and $J- = J_x - iJy$, interpret them as raising (lowering) operator and derive the result : $J_\pm | j, m > = [j (j + 1) - m(m \pm 1)]^{1/2} \hbar | j,m\pm1|>$

(b) Obtain Clebsch-Gordan coefficients for the addition of orbital and spin angular momentum for electron in *p*-state. **7**

OR

Discuss the spin wave functions for a system of two spin ½ particles. From this, explain the triplet and singlet states.

4. (a) Obtain Klein-Gordan equation for a charged particle moving in an electromagnetic field. Show that this equation reduces to the Schrödinger equation of motion for the particle in an electromagnetic field in the non-relativistic limit. **7**

OR

Show that the Dirac matrices must be even dimensional. Calculate the charge density and current density for a free Dirac electron.

(b) Show that the Dirac's equation automatically endows the hypothetical spinning motion of the electron. **7**

OR

Prove that a Dirac electron has a magnetic moment given by :

$$\mu = \frac{e\hbar\sigma'}{2mc}$$

5. Write short answers : **14**

(1) Do J^2 and J_z have simultaneous eigen functions ? If yes, write the form of functions.

(2) Write the values of commutations, $[J_x, J_y]$ and $[J^2, J_z]$.

(3) What do you mean by projection operator ?

(4) What is the physical significance of negative energy states ?

(5) Write Dirac's 4×4 matrices.

(6) What are the short comings of Klein-Gordon equation ?

(7) For the Dirac matrices, show that $\alpha_x = \frac{1}{2}[\alpha_x\alpha_y,\alpha_y]$

(8) Which particles having integral spin ?

(9) Write CPT theorem.

(10) Electrons have parity is _____. (odd/even)

(11) Define : Stripping reactions.

(12) What is the parity relation between particles and antiparticles ?

(13) Define compound nucleus.

(14) Define : Pick-up reactions.