

## M.Sc. Sem.-4 Examination

507

Physics

April-2025

Time : 2-30 Hours]

[Max. Marks : 70

- Q.1 (A) Discuss Continuum Theory on Nuclear reactions in detail. [07]  
 (B) In case of Shell model explain the magnetic moments of nuclei in detail. [07]
- OR**
- Q.1 (A) Define compound nucleus and discuss the relation between  $\sigma_c(x)$  and  $G_c(x)$ . [07]  
 (B) Write short note on spin-orbit potential. [07]
- Q.2 (A) Discuss CP-violation on natural K-Meson in detail. [07]  
 (B) Write a short note on Quarks, Flavors and Colours. [07]
- OR**
- Q.2 (A) Write the classification of elementary particles on the basis of their spin and explain in details on the fundamental forces. [07]  
 (B) Explain in details on Parity and Charge conjugate. [07]
- Q.3 (A) Define Clebsh-Gordan coefficients. Discuss their significance briefly. [07]  
 (B) Find the commutation relations followed by the components of angular momentum and express their vector notation. [07]
- OR**
- Q.3 (A) Write the eigen value and eigen vector relations for the operators  $J^2$  and  $J_z$ . Get the matrices for  $J^2$  and  $J_z$ . [07]  
 (B) In a representation in which  $L^2$  and  $L_z$  have concurrent eigenfunctions, what is the value of the uncertainty product  $(\Delta L_x)(\Delta L_y)$ . Remark on the value of such product when  $l = 0$ . [07]
- Q.4 (A) Obtain Klein-Gordon equation. Using probability density and current density, show that Klein-Gordon equation is unphysical for a relativistic particle. [07]  
 (B) Dirac preferred a 1<sup>st</sup> order equation both in time and space coordinates. Why? [07]  
 Also, explain why the dimension of the Dirac's matrices has to be even?
- OR**
- Q.4 (A) Show that the Dirac's equation automatically endows the hypothetical spinning motion of the electron. [07]  
 (B) State the expression for energy of a charged particle obeying Klein-Gordon equation in a Coulomb potential. Explain the significance of the different terms. [07]
- Q.5 Answer in brief **Any Seven** questions from the following: (Each question is of **two** mark). [14]  
 (i) Define direct reaction.  
 (ii) A condition for nuclear isomerism is  
 A. The presence of energy level near the ground state  
 B. The presence of an energy level near the ground state differing strongly in angular momentum  
 C. The presence of states differing in angular momentum  
 D. The existence of mirror nuclei  
 (iii) The spin of the particles can have half integral values and integral values are called \_\_\_\_\_ and \_\_\_\_\_.

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- (iv) Write the difference between Square well potential and Harmonic Oscillator potential.
  - (v) Parity corresponding to
    - A. Electron is even but that of proton is odd
    - B. Electron is odd but that of proton is even
    - C. Electron and proton is odd
    - D. Electron and proton is even
  - (vi) The intrinsic parity of Boson is \_\_\_\_\_ and that of Fermions \_\_\_\_\_.
  - (vii) What will be the values of commutator  $\sigma_x \sigma_y$ ?
  - (viii) If  $j = \frac{3}{2}$ , then how many rows and column in matrix representation of  $J_z$ ?
  - (ix) What is the unit of spin angular momentum?
  - (x) What are negative energy states? What is a hole?
  - (xi) Show that  $\alpha_x \alpha_y + \alpha_y \alpha_x = 0$ .
  - (xii) Differentiate between the Dirac and Klein-Gordon equations.
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\*\*\* PAPER ENDS \*\*\*