

M.Sc. Sem.-4 (Rep) Examination

507 - Physics

October-2025

Time : 2-30 Hours]

[Max. Marks : 70

- Q.1 (A) Write the different types of nuclear reactions and derive the total scattering cross section in detail. [07]
 (B) What do you mean by compound nucleus and explain in detail. [07]
- OR**
- Q.1 (A) Define resonance and discuss Breit-Wigner formula for $l = 0$. [07]
 (B) Discuss Harmonic oscillator potential in detail. [07]
- Q.2 (A) Discuss quarks, Flavors and colour of particle in detail. [07]
 (B) Write the particle classification in terms of their spin and discuss fundamental interactions in detail. [07]
- OR**
- Q.2 (A) Write short note on CP – violation in K^0 meson decay. [07]
 (B) Discuss parity and G-parity in detail. [07]
- Q.3 (A) In a representation in which L^2 and L_z have simultaneous eigenfunctions, what is the value of the uncertainty product $(\Delta L_x)(\Delta L_y)$. Comment on the value of this product when $l=0$. [07]
 (B) What are the Clebsh-Gordan coefficients? Explain their significance briefly. [07]
- OR**
- Q.3 (A) State the commutation relations obeyed by the components of angular momentum and express their vector notation. [07]
 (B) State the eigen value and eigen vector relations for the operators J^2 and J_z . Hence, obtain the matrices for J^2 and J_z . [07]
- Q.4 (A) Find plane wave solution of Klein-Gordan (KG) equation for a charged particle in the Coulomb field. Explain how it interprets the fine structure of hydrogen-like atoms. [07]
 (B) Explain the Dirac equation for a relativistic electron placed in a central potential. Thus, deduce the total angular momentum and quantum numbers of electron. [07]
- OR**
- Q.4 (A) Illustrate the Dirac's equation automatically gives the hypothetical spinning motion of the electron. [07]
 (B) Prove that $L = r \times p$ does not commute with the free particle Dirac Hamiltonian, while $J = L + S$ does, where, $\vec{S} = \frac{1}{2} h \vec{\Sigma} \begin{bmatrix} \vec{\sigma} & 0 \\ 0 & \vec{\sigma} \end{bmatrix}$. Write the physical significance of above expression. [07]
- Q.5 Answer in brief **Any Seven** questions from the following: (Each question is of two mark). [14]
- (i) State CPT theorem.
 - (ii) Write the strangeness value of hyperon particle and anti-particles
 - (iii) Intrinsic parity of BOSON and FERMIONS are _____ and _____.
 - (iv) What do you mean by quarks and write their charge values.
 - (v) Write limitations of liquid drop model.

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- (vi) In case of square well potential has _____ edge while Harmonic oscillator potential has _____ edge.
- (vii) Which one is precise?
- [A] $L.S \left| \frac{3}{2}, m \right\rangle = \frac{1}{2} \left| \frac{1}{2}, m \right\rangle$
- [B] $L.S \left| \frac{3}{2}, m \right\rangle = \frac{1}{2} \left| \frac{5}{2}, m \right\rangle$
- [C] $L.S \left| \frac{3}{2}, m \right\rangle = \frac{1}{2} \left| \frac{3}{2}, m \right\rangle$
- [D] $L.S \left| \frac{3}{2}, m \right\rangle = \frac{1}{2} \left| \frac{7}{2}, m \right\rangle$
- (viii) If J_x , J_y and J_z are three angular momentum operators and $J_+ = J_x + iJ_y$ and $J_- = J_x - iJ_y$, then
- [A] $[J^2, J_{\pm}] = i\hbar$
- [B] $[J^2, J_{\pm}] = \nabla$
- [C] $[J^2, J_{\pm}] = \frac{i\hbar}{2}$
- [D] $[J^2, J_{\pm}] = 2\hbar J_x$
- (ix) The fine structure constant of the Hydrogen atom is
- [A] 1/137
- [B] 1/13.7
- [C] 1/1.37
- [D] 1/1370
- (x) Write expression of the energy of the particle interact with EM fields with physical significance of each term.
- (xi) Give Dirac's interpretation of negative energy states.
- (xii) Write expression of the energy of the particle interact with EM fields with physical significance of each term.

*** PAPER ENDS ***