Seat No. : _____

ML-128

March-2019

M.Sc.., Sem.-IV

507 : Physics

(Nuclear Physics – II & Advanced Quantum Mechanics – II)

Time : 2:30 Hours] **[Max. Marks : 70**

Instructions : Symbols have their usual meanings.

1. (a) (i) Discuss types of nuclear reactions with necessary example and state the classification of energy. **7**

(ii) State the names of conservation laws and derive the amplitude $A_E = \frac{\psi(r)}{2\pi}$

$\left[\frac{i\hbar}{(E - E_0 + i\gamma/2)}\right]$ in case of Breit Weigner dispersion. **7**

OR

(i) What do you mean by compound nucleus and derive the relation between Probability of decay of compound nucleus $G_c(x)$ and scattering cross-section of formation of compound nucleus $\sigma_c(x)$.

(ii) Discuss Harmonic oscillator in detail.

(b) Write short answer : (any **four**) **4**

(1) State the limitation of liquid drop model.

(2) Square well potential has _____ edge while harmonic oscillator potential has _____ edge.

(3) What do you mean by pick up reaction ?

(4) In case of vibration state in collective model, when λ=l give the names of different modes observed.

(5) State the discrepancies in case of the magnetic moment of nuclei.

(6) What is the total transparency when k < K in terms of E and V_0 ?

2. (a) (i) Write briefly fundamental interactions and nucleonium [nucleon-anti-nucleon system] in detail. **7**

(ii) Explain Parity and G-parity in detail. **7**

OR

(i) Explain Isospin and time reversal in detail.

(ii) Write short note on CP-violation in K° meson decay.

(b) Write short answer : (any **four**) **4**

(1) Define charge conjugate.

(2) What is the spin of Fermions particle ?

(3) State the electric charges of three quarks.

(4) State the CPT theorem.

(5) What is the strangeness value of Σ-Hyperons ?

(6) Intrinsic parity of BOSON is _____ and that of FERMIONS _____.

3. (a) (i) For s = 1, find out the matrix representations of J_x, J_y and J_z. **7**

(ii) For spin state s = 1 find out S_x' and S_y'. The new basis states are **7**

$$|a\rangle = \frac{-1}{\sqrt{2}}[|1\rangle - |-1\rangle],\ |b\rangle = \frac{-i}{\sqrt{2}}[|1\rangle + |-1\rangle] \text{ and } |c\rangle = 0$$

OR

(i) What is the wave function for s = 1/2 if the spin component in the direction of the unit vector 'n' has value(l/2)ħ ? [Given : Evidently $(\vec{s}.\vec{n})\chi = (\hbar/2)\chi$]

(ii) Define Pauli's spin matrices σ_x, σ_y, and σ_z. Show that

(1) $\sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 3$

(2) $\sigma_+ \sigma_- = 2(1 + \sigma_z)$

(3) $[S_x, S_y] = \hbar S_z$

(b) Write short answer : (any **three**) **3**

(1) What will be the value of α_+^2 ?

(2) What will be the value of $[S^2, S_z]$?

(3) What is the unit of Pauli's spin matrices σ_x ?

(4) For s = 3, how many spin states are there ?

(5) When lowering operator J_ is operated on $|j + 2, m + 3\rangle$, then what will be the new states and eigen value ?

4. (a) (i) Obtain Klein-Gorden equation. Using probability density and current density show that Klein-Gorden equation is unphysical for relativistic particle. **7**

(ii) State the expression for energy of a charged particle obeying Klein-Gorden equation in a Coulomb potential. Explain the significance of the different terms. **7**

OR

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

(ii) Dirac preferred a 1^{st} order equation both in time and space co-ordinates. Why ? Also explain why the dimension of the Dirac's matrices has to be even ?

(b) Write short answer : (any **three**) **3**

(1) What are negative energy states ? What is hole ?

(2) Show that $\alpha_x\alpha_y + \alpha_y\alpha_x = 0$

(3) Give the physical interpretation of Dirac's matrices.

(4) Prove that $[\alpha_y\alpha_z, \alpha_y] = 2\alpha_y$.

(5) Distinguish the Klein-Gorden and Dirac's equations.