YMCA UNIVERSITY OF SCIENCE & TECHNOLOGY, FARIDABAD

M.Sc. PHYSICS 3rd SEMESTER (UNDER CBS)

ADVANCED QAUNTUM MECHANICS (PH-511)(Reappear)

Time: 3 Hours | Max. Marks: 60

Note:
1. *It is compulsory to answer the questions of Part -1. Limit your answers within 20-40 word in this part.*
2. *Answer any four questions from Part -2 in detail.*
3. *Different parts of the same question are to be attempted adjacent to each other.*

PART -1

Q1 (a) What do you mean by expectation value of a dynamical quantity? (2)

(b) What are identical particles? (2)

(c) Differentiate between symmetric and anti-symmetric wave function. (2)

(d) Derive the equation of motion of matter waves for a free particle. (2)

(e) An electron has a speed 1.05×10^4 m/s within the accuracy of 0.01%. Calculate the uncertainty in the position of the electron. (2)

(f) Prove that any interchange of two identical particles leaves the average value unchanged. (2)

(g) Differentiate between Bose Einstein Statistics and Fermi Dirac Statistics. (2)

(h) Prove that the eigen values of a particle exchange operator are ± 1. (2)

(i) Give one example each of a Hamiltonian and a Lagrangian (2)

(j) The de- Broglie wavelength of e^- is 30 A. Calculate the phase velocity and group velocity of the matter wave associated with the electron. (2)

PART -2

Q2 (a) Explain how negative energy state of an electron implies the existence of positron. (5)

(b) Prove the non-uniqueness of electromagnetic potentials and explain Gauge invariance. (5)

Q3 (a) Describe in detail creation and annihilation operators. (5)

(b) What do you understand by electromagnetic scalar and vector potentials? Hence derive the expression for magnetic and electric dipole moment. (5)

Q4 (a) Prove that the energy levels of a harmonic oscillator are not continuous but an integral multiple of hν. (5)

(b) Explain the classical approach to field theory and also derive the Poisson's equation in electromagnetic field. (5)

Q5 (a) Derive relativistic Lagrangian and Hamiltonian of a charged paticle in an electromagnetic field. (5)

(b) What is Central field approximation method for evaluation of potential energy function of many electron systems? (5)

Q6 (a) Show that classical field equation in terms of functional derivative of Lagrangian $L=L[\psi(r,t)\psi(r,t)]$ is given by $\frac{\partial L}{\partial \psi} - \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\psi}}\right)=0$ (5)

(b) If α and β are Dirac matrices then prove that $\alpha_x \alpha_y \alpha_z = \frac{1}{2}[\alpha_x \alpha_y \alpha_z \beta, \beta]$ (5)

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Q7 Write short note on:

(a) Klien-Gordan equation in electromagnetic field

(b) Hydrogen atom