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Total Number of Pages: 02

Course: M.Sc.I
Sub_Code: FPYC901

9th Semester Regular Examination: 2024-25
SUBJECT: ADVANCED QUANTUM MECHANICS & QUANTUM FIELD THEORY
BRANCH(S): M.Sc.I(AP)

Time: 3 Hours

Max Marks: 70

Q.Code: R006

Answer Question No.1 (Part-I) which is compulsory, any five from rest (Part-II)
The figures in the right-hand margin indicate marks.

Part-I

Q1 Answer the following questions: (2 x 10)

- Write the drawbacks of Klein-Gordon equation.
- What is the non-relativistic limit of Dirac equation?
- Define energy projection operators and discuss their properties.
- Show the current density, $j_\mu = -\frac{1}{2}(\Phi\partial_\mu\Phi^* - \Phi^*\partial_\mu\Phi)$ satisfies the continuity equation, $\partial^\mu j_\mu = 0$.
- Define renormalization.
- Show that $\gamma_\mu\gamma^\nu\gamma^\mu = -2\gamma^\nu$.
- What do you mean by normal order product of operators and fields?
- What is the charge of the particles associated with real and complex field?
- Write down the covariant form of Dirac equation.
- What is tensor term in bilinear covariant?

Part-II

Long Answer Type Questions (Answer Any five)

- Q2 a) Solve Dirac equation for a free particle in motion. (8+2)
b) Discuss the properties of the Dirac matrices.
- Q3 a) What are bilinear covariant? Show how the vector and axial vector transform under proper orthotonus Lorentz transformation and space inversion. (7+3)
b) Show that a particle described by the Dirac equation corresponds to a spin $\frac{1}{2}$ particle.
- Q4 a) Discuss Dirac Hole theory. (7+3)
b) Describe pair production and pair annihilation.

- Q5** a) Describe quantization of charged scalar meson field. **(5+5)**
b) Find the expression for Hamiltonian and momentum operators from the charged scalar meson field.
- Q6** a) State Noether's theorem. Find the conserved quantities arising out of rotational invariance. **(7+3)**
b) Discuss what happens to the Lagrange equation and quantization conditions on going from discrete to continuous system.
- Q7** a) Quantize the complex Klein-Gordon field and find the momentum and charge of the field. **(7+3)**
b) Discuss the time-ordered product of operators.
- Q8** Write short notes on **(5+5)**
a) Zitterbewegung
b) Quantization of electromagnetic field