(*b*) Explain the concept of Dirac field. Discuss Lagrangian formulation of Dirac field and momentum expansion of the Dirac field. Express total energy and momentum in terms of annihilation and creation operators.

2016

RELATIVISTIC QUANTUM MECHANICS AND FIELD THEORY

Time : Three Hours] [*Maximum Marks* : 80

Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

SECTION-A

1. Answer any **four** of the following : 4×4

(*a*) Explain Klein-Gordon equation and its drawbacks.

(*b*) Explain the important properties of the gamma-matrices and its applications.

(*c*) What is a field and field strength? Write classical field equation.

(*d*) Explain field quantization and discuss Dirac field.

(*e*) Discuss the importance and main properties of Dirac matrices.

(*f*) Explain Gauge invariance and charge conservation.

OR

2. Answer **all** questions from the following : 2×8

(*a*) Explain difference between quantum mechanics and relativistic quantum mechanics.

(*b*) Discuss physical significance of negative energy states.

(*c*) Differentiate between global and local gauge symmetries.

(*d*) Explain basic difference between Klein-Gordon equation and Dirac equation.

(*e*) What do you mean by central potential? Discuss its important properties.

(*f*) How does Noether's theorem imply conservation of electrical charge?

(*g*) Give your arguments why gauge invariance is required ?

(*h*) What are the various types of scalar fields? Explain charged scalar field with example.

SECTION-B

Answer **all** questions : 16×4

3. (*a*) Derive expression for energy of a charged particle obeying Klein-Gordon equation in a coulomb potential. Explain the significance of different terms.

OR

(*b*) Explain the difference between Klein-Gordon equation and Dirac equation. Derive Dirac equation for a free particle. Express Dirac's equation in the covariant form.

4. (*a*) Describe the plane wave solution of Dirac equation. Determine the energy eigen functions. Discuss the energy levels of a free Dirac particle.

OR

(*b*) Discuss the intrinsic magnetic moment associated with the spin of the electron in electromagnetic field. Explain spin-orbit interaction.

5. (*a*) Explain Noether's theorem and its consequences. Show that time, translation and rotational independence derive energy, momentum and angular momentum conservation.

OR

(*b*) (*i*) Discuss arguments for gauge invariance. What is a covariant derivatives and discuss its importance in relativistic quantum mechanics.

(*ii*) Explain classical field equation.

6. (*a*) Explain the concept of field and field quantization. Describe the neutral scalar meson field and its importance. Discuss canonical quantisation of a scalar field.

OR