GIET UNIVERSITY, GUNUPUR – 765022

RN19MSC004

Roll No: | | | | | | |

Total Number of Pages : 2 AR-18 M.SC

M.Sc 3rd SEMESTER REGULAR EXAMINATIONS, NOV/DEC 2019-20

Subject code: CC-PHY-301

Subject: Relativistic Quantum Mechanics & Field Theory

Time: 3 Hours Max Marks: 80

The figures in the right hand margin indicate marks.

SECTION A

Q.1 Answer any four of the following: (4 x 4=16 Marks)

a Discuss the drawbacks of Klein-Gordon equation. 4

b Obtain Dirac equation for a free particle moving in a central field. 4

c Express Dirac equation for a free particle in covariant form . 4

d Explain gauge invariance with examples. 4

e Derive the anti commutation relation $r^{\mu}r^{\vartheta}+r^{\vartheta}r^{\mu}=2g^{\mu\vartheta}$ I for the Dirac gamma matrices. 4

f Construct a suitable Lagrangian density for Dirac field. 4

OR

2. Answer all the questions from the following (2 x 8=16 Marks)

a Write down the reasonings that led to the Dirac equation. 2

b Discuss how negative energy was interpreted. 2

c Discuss how the spin of electron came into existence and exist with two states. 2

d Write Dirac matrices and explain why these are 4 x 4 matrices unlike pauli matrices which are 2 x 2. 2

e What is improper Lorentz transformation? How it differs from proper Lorentz transformation? 2

f Write down Dirac equation for an electron in electromagnetic field. 2

g What are creation, annihilation and number operators? 2

h Write down Lagrangian for charged scalar meson field. 2

SECTION-B

3. Answer all Questions: (16 x4 = 64 Marks)

a i) Derive Klein-Gordon equation for a relativistic particle and obtain continuity equation for its probabilities. Show that its probability density is not positive and definite. 8+8

ii) Derive Dirac equation for a relativistic spin ½ particle and show that its probability

density is +ve and definite.

OR

b	i) Obtain Dirac matrices and establish their properties. ii) Explain Dirac's Hole theory.	10+6
4a	(i) Obtain the free particle solution of Dirac equation. ii) Starting from Dirac equation for a free particle moving in a central field, obtain the expression for potential energy due to spin-orbit coupling.	8+8

OR

b.	Obtain Dirac equation for an electron in an e.m field. Reduce this equation into non-relativistic form and hence obtain an expression for magnetic moment of the electron.	16
5a	i)Discuss the Lagrangian formulation of a continuous system as a limiting case a discontinuous system. ii) Give an account of the Hamiltonian formulation of field theory and establish the equal time commutation relation for the fields.	8+8

OR

b	State and prove Noether's theorem for a Dirac field and hence derive the conservation of angular momentum from isotropy of space.	16
6a	What is second quantization? Quantize the free Dirac field, explaining clearly the need for the equal time anti-commutation relation.	4+12

OR

b	Discuss the quantization of neutral scalar fields and obtain the expression of Hamiltonian in terms of creation and annihilation operators for real scalar field.	16