LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FOURTH SEMESTER – **APRIL 2015**

PH 4959 - PARTICLE PHYSICS

Date : 24/04/2015 Dept. No. Max. : 100 Marks
Time : 09:00-12:00

SECTION-A

Answer **ALL** the questions. (10 x 2 = 20 Marks)

1. State two properties of the quanta of (i) electromagnetic (ii) weak interaction field.
2. Write down the multiplets of the isospin I=3/2 baryons, their quark constitution and their charge.
3. What are spinors?
4. Define the helicity operator. What is its use?
5. Are neutral current decays observed in atomic systems? Why?
6. Write down the (i) gluon and (ii) quark Lagrangian density.
7. How was the weak interaction discerned? Why was it considered weak?
8. What is the lower limit for the mass of the Higgs boson?
9. Estimate the coupling constant between the electron field and the Higgs field .
10. What are colour singlets?

SECTION -B

Answer any **FOUR** questions. (4 x 7.5 = 30 Marks)

11. Describe the spectrum of baryon states on the basis of a simple shell model of three confined quarks.
12. Write down the Lagrangian density for a charged scalar field and show that it is invariant under charge conjucation.
13. Show that the law of conservation of particles arises as a consequence of global U(1) symmetry.
14. Explain how the proposed approximate masses for the $W^{\pm}$, Z Bosons as the low energy limit of Weinberg-Salam theory is in good agreement with the experimental values.
15. Discuss the quark-antiquark interaction at short distance and account for the slow motion of the Charmonium and bottomonium.

SECTION -C

Answer any **FOUR** questions. (4 x 12.5 = 50 Marks)

16. Write down the Lagrangian density for an electromagnetic field and establish the following:
    (i) Maxwell's equation (ii) General solution of Maxwell's equation in free space.
17. From Dirac's equation for free particle, derive information about (i) intrinsic spin of the Dirac particle (ii) plane wave solution of the Dirac equation.
18. (a) Construct a Lagrangian density which is invariant under a local SU(2) transformation as well as a local U(1) transformation.
    (b) Explain how introducing mass brings about the local symmetry breaking.

19. (a) Construct a gauge-invariant and Lorentz-invariant expression for the dynamical part of the Langragian density for the electron and the electron neutrino.

    (b) Discuss the coupling of the lepton fields to the W gauge fields.

20. Show from QCD using asymptotic freedom that the effective strong interaction coupling constant decreases with increase in momentum transfer in contrast to that in QED.

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