LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

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

FOURTH SEMESTER – **APRIL 2015**

PH 4810 - QUANTUM MECHANICS - II

Date : 15/04/2015 Dept. No. Max. : 100 Marks
Time : 09:00-12:00

PART A

Answer **ALL** questions: **10 x 2 = 20 marks**

1 Which of the following transitions are electric dipole allowed
   a. 1s→2s
   b. 1s→2p
2 Write the principle of LASER.
3 A muon is travelling through the laboratory with three-fifth the velocity of light.How long does it last? (Life time of muon is 2×10^{-6}s).
4 Calculate the velocity of an elementary particle whose mass is 10 times its rest mass.
5 If αis a Dirac matrix, prove that$\alpha_x = \frac{1}{2}[\alpha_x \alpha_y, \alpha_y]$
6 Write a short note on Lamb shift.
7 What is symmetry transformation?
8 Illustrate exchange degeneracy with example.
9 Describe Bremsstrahlung and pair production.
10 Draw the Feynman diagrams corresponding to positron creation and annihilation.

PART B

Answer **ANY FOUR** questions **4x7.5=30 marks**

11 Obtain the condition under which stimulated emission equals spontaneous emission. If the temperature of the source is 500K, at what wavelength will both the emissions be equal?
12 (a)Discuss the invariant interval in detail. **(3 marks)**
   (b)Two events occuring at the same place in an interval frame are seperated by a time interval of 4 secs. What is the spatial difference between these two events in an interial frame in which the events are separated by a time interval of 6 secs. **(4.5 marks)**
13 Show that (α . A) (α . B) = (A.B) + iσ'(A×B) where A and B commute with α and σ' = $\begin{bmatrix} \sigma & 0 \\ 0 & \sigma \end{bmatrix}$
14 Prove that the operator cα, where α stands for Dirac matrix can be interpretedas the velocity operator.
15 List and explain the configuration space rules for Feynman graphs.
16 Discuss the work-energy theorem in relativity.

PART – C

Answer any **FOUR** questions: **4 x 12.5 = 50 marks**

17 Discuss the time dependent perturbation theory with reference to harmonic perturbation and obtain an expression for transition probability.

18 (a) Explain the salient features of Minkowski's space time diagram.

(b) Two lumps of clay each of mass (rest) m, collide head – on at 3/5 c. They stick together. What is the mass (m) of the composite lump? **(6.5 +6)**

19 Show that Dirac equation gives positive and negative energy solutions. Explain pair production and pair annihilation in the energy spectrum of a free Dirac particle.

20 (a) N non-interacting Bosons are in an infinite potential well defined by $v(x) = 0$ for $0<x<a$, $v(x) = \infty$ for $x<0$ and for $x>a$. Find the ground state energy of the system. What would be the ground state energy if the particles are fermions? **(6 marks)**

(b) Prove that the parity of spherical harmonics $Y_{l,m}(\theta, \varphi)$ is $(-1)^l$. **(6 marks)**

21 Discuss the procedure for quantization of complex scalar field. From the discussion explain the annihilation, creation and particle number operators.

22 (a) Explain Compton's scattering and find an expression for the change in wavelength of the scattered X- ray beam.

(b) Discuss the effect of time reversal in the time – dependent Schrodinger equation. **(7.5 +5)**

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