UNIVERSITY OF THE PUNJAB

Roll No. in Fig. ....

B.S. 4 Years Program / Eighth Semester – 2019

Roll No. in Words. ....

Paper: Particle Physics-IV
Course Code: PHY-428 Part – I (Compulsory) Time: 15 Min. Marks: 10

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Signature of Supdt.:

ATTEMPT THIS PAPER ON THIS QUESTION SHEET ONLY.
Division of marks is given in front of each question.
This Paper will be collected back after expiry of time limit mentioned above.

Q.1. Encircle the correct option. **(10x1=10)**

Question 1: $(1 \times 10 = 10)$

Each question has four possible answers. Select the correct answer and encircle it.

(i) $TrI =$

(a) 0 (b) 4
(c) 1 (d) None of the above

(ii) In term of anti-symmetric field strength tensor, Maxwell's equations take the compact form

(a) $\partial_\mu F^{\mu\nu} = 0$ (b) $\partial_\mu A^\mu = j^\nu$
(c) $\partial_\mu F^{\mu\nu} = j^\nu$ (d) $\partial_\mu A^\mu = 0$

(iii) Schrodinger equation is used for ______________ particles.

(a) Non-relativistic (b) Relativistic
(c) Both (a) & (b) (d) None of the above

(iv) According to Feynman rules, spin 0 boson propagator is

(a) $\frac{1}{p^2+m^2}$ (b) $\frac{i}{p^2-m^2}$
(c) $\frac{1}{p^2-m^2}$ (d) $\frac{i}{p^2+m^2}$

(v) $e^-e^+ \to \gamma\gamma$ is the ______________ process.

(a) Pair creation (b) Pair annihilation
(c) Scattering (d) None of the above

(vi) The fine structure constant α is

(a) $4\pi e^2$ (b) $4\pi/e^2$
(c) $e^2/4\pi$ (d) $e^2/4\pi^2$

(vii) In a non-relativistic limit ______________.

of

(a) $\underline{p} \to 0$ (b) $|\underline{p}| \to 0$
(c) $m \to 0$ (d) Both (b) & (c)

P.T.O.

(viii) Which of the following is Lorentz gauge condition

(a) $\partial_\mu A_\mu = 0$ (b) $\partial^\mu A^\mu = 0$

(c) $\partial^\mu A_\mu = 0$ (d) None of the above

(ix) The lowest order invariant amplitude of electron scattering by electromagnetic field has ______________ vetex factor(s).

(a) zero (b) one

(c) two (d) three

(x) "t" is a Mandelstam variable which is defined as______________.

(a) $(P_A + P_B)^2$ (b) $(P_A - P_C)^2$

(c) $(P_A - P_D)^2$ (d) $(P_A - P_B)^2$

UNIVERSITY OF THE PUNJAB

B.S. 4 Years Program / Eighth Semester – 2019

Roll No. ....

Paper: Particle Physics-IV
Course Code: PHY-428 Part – II

Time: 2 Hrs. 45 Min. Marks: 50

ATTEMPT THIS (SUBJECTIVE) ON THE SEPARATE ANSWER SHEET PROVIDED

Question 2:

Give short answers of the following questions.

(i) For a scattering process $AB \to CD$, show that $s + t + u = m_a^2 + m_B^2 + m_C^2 + m_D^2$. (3)

(ii) Write an expression for decay rate of the process $A \to 1 + 2 + 3 + 4$. (2)

(iii) Define lab frame of reference. (2)

(iv) Prove that $Tr(\gamma_5) = 0$. (3)

(v) Write $\overline{u}(k)\gamma u(k)$ in terms of components of a matrix. (2)

(vi) Differentiate b/w real and virtual particles. (2)

(vii) Draw lowest order Feynman diagrams for Moller scattering scattering. Also write the invariant amplitude follows from Feynman rules. (3)

(viii) Using equation of motion, write down the propagator for the relativistically moving spin-1/2 particle. (3)

Question 3: (10)

In the center-of-mass frame for the process $AB \to CD$

$$dQ = \frac{1}{4\pi^2}\frac{p_f}{4\sqrt{s}}d\Omega. \qquad F = 4p_i\sqrt{s}$$

and hence the differential cross section is

$$\frac{d\sigma}{d\Omega}|cm = \frac{1}{64\pi^2 s}\frac{p_f}{p_i}|\mathcal{M}|^2,$$

where $d\Omega$ is the element of solid angle about $\mathbf{p}_C$, $s = (E_A + E_B)^2$, $|\mathbf{p}_A| = |\mathbf{p}_B| = p_i$ and $|\mathbf{p}_C| = |\mathbf{p}_D| = p_f$.

Question 4: (10)

Use the Feynman rules to obtain the invariant amplitude for spin-1/2 process $e^-e^+ \to \mu^-\mu^+$ and write this amplitude in terms of Mandelstam variables.

Question 5: (10)

Prove that the unpolarized amplitude for $e^-\mu^- \to e^-\mu^-$ in extreme relativistic limit is

$$|\overline{\mathcal{M}}|^2 = \frac{8e^4}{q^4}[(k'.p')(k.p) + (k'.p)(k.p')]$$

by using $|\overline{\mathcal{M}}|^2 = L_{e^-}^{\mu\nu} L_{\mu\nu}^{muon}$ with $L_{e^-}^{\mu\nu} = \frac{1}{2}Tr[(\not{k}' + m)\gamma^\mu(\not{k} + m)\gamma^\nu]$, where m is the mass of electron, k and k' are the momentum of incident and scattered electron respectively.