M.Sc. Examination, 2019

Semester-IV

Physics

Course: MPC-465 (Special Paper)

(Particle Physics-II)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***Question No. 1*** and ***any three*** from the rest of the questions.

1. Answer any *five* questions. **2 x 5**
   a. Considering the isospin invariance find the ratio $\sigma(p\,p \rightarrow \pi^+ d)/\sigma(n\,p \rightarrow \pi^0 d)$.
   b. Define P_R and P_L operators. Show that $P_R + P_L = 1$ and $P_R\,P_L = 0$.
   c. Why did we have to introduce the colour quantum numbers to quarks but not to leptons?
   d. What do you mean by assymptotic freedom and color confinement?
   e. Calculate the number of phase parameters of a 3x3 unitary matrix.
   f. Verify the statement: neutrinos in the standard model are always left-handed particles but electrons are not.
   g. Write down the Feynman diagrams of nuclear beta decay and π^- decay processes.

2. What is τ-θ puzzle? Briefly explain the Wu's experiment to understand parity violation in the weak interaction. How do scalar, vector and pseudoscalar transform under parity transformaton? How to define the parity of a composite object? **2+4+3+1**

3. Find the correspondonce between an SU(2) rotation on a two dimensional complex spinor and an O(3) roation on a real position vector. Show that when a vector roates through an angle θ, the spinor rotates through an angle $\theta/2$. **10**

4. Find an expression for the charge conjugation operator from Dirac equation. Write down the Lagrangian for a real scalar field. Hence obtain the Klein-Gordon equation. Write down the Feynman diagram and obtain the matrix amplitude for the process $e^+e^- \rightarrow \mu^+\mu^-$. **3+1+2+4**

5. What are the fundamental quark and antiquark multiplates? Using Young tableau method of group multication find the product of $3 \otimes 3 \otimes 3$ for SU(3) group. What are the members of the baryonic decuplet state? Calculate proton's magnetic moment if the wave function of the proton is given by $(u\uparrow u\downarrow d\uparrow + u\downarrow u\uparrow d\uparrow - 2u\uparrow u\uparrow d\downarrow + \text{permutations})/\sqrt{18}$. **2+2+3+3**

6. What is the Cabibbo mixing angle? With this mixing how can one explain the observed $K^+ \rightarrow \mu^+\nu_\mu$ decay process? Briefly explain how the introduction of the charm quark explains the very small decay rate of the $K^0_L \rightarrow \mu^+\mu^-$ process. Show that CP-invariance forces the elements of the quark mixing matrix to be real. Hence comment on the CKM mixing matrix. **1+2+4+2+1**

7. Discuss the spontaneous symmetry breaking of a global U(1) symmetry and show that it generates a massless Goldstone boson. Why don't we see these bosons if we consider the symmetry breaking of a local U(1) gauge symmetry? What should be the choice of the Higgs boson to break the $SU(2)_L \times U(1)_Y$ gauge symmetry? Why don't we break the local $SU(3)_c$ symmetry of the standard model? **6+2+1+1**
