Birla Institute of Technology and Science - Pilani, Pilani Campus

Semester I (Session 2022-23)

Midsemester Examination (Closed Book)

Particle Physics (PHYF 413)

Date : 01/11/2022 Weightage : 25 %

Time: 90 Mints. Max. Marks: 25

Q1: (a) Consider the following interaction process; $A + B \rightarrow C + D + E$ with masses, m_A, m_B, m_C and m_D and m_E, respectively. Find the threshold kinetic energy of particle A in the lab frame to just produce the particles C, D and E. (b) Express 800 kg m/sec and 100 kg into energy units (Joule) and then convert it in MeV. [5]

Q2: Assuming collision process to be $A + B + C \rightarrow 1 + 2 + 3$; Write an expression for dN (no. of available states for particles having momentum in the range $\vec{p}$ to $\vec{p} + \vec{dp}$) using Dirac-delta function for momentum conservation. Also write relation between H_{fi} and Lorentz invariant matrix element M_{fi}. [5]

Q3: (a) Obtain Dirac equation in the covarient form. Also find square properties of Dirac gamma matrices using the properties of Dirac α_s and β matrices. (b) Without solving Maxwell equation, I mean using an appropriate identity, determine the em potential A^μ for a muons which constitute a four current given by $J^\mu = -eN_A N_C (p_A + p_C)^\mu e^{i(p_C - p_A).x}$,. Here N_A and N_C are normalization constants. [5]

Q4: (a) Write Klein-Gordon equation for an alpha particle moving under the action of an em field given by A^μ. (b) For scattering process $A + B \rightarrow C + D$, draw simplest t-channel Feynman diagram. Using Feynman rules for QED (forgetting the spin!), write an expression for Lorentz invarient amplitude $-iM$. [5]

Q5: For a two body decay process, $A \rightarrow 1 + 2$, write an expression for the decay rate using Fermi's golden rule in terms of 6D three momentum integral. Then integrate it to obtain the final expression for the Decay rate. [5]

** Best Wishes **