NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PURE AND APPLIED SCIENCE
SEPTEMBER 2020_1 EXAMINATION

COURSE CODE: **PHY 401**
COURSE TITLE: **ELEMENTARY PARTICLES PHYSICS**
CREDIT UNIT: **3**
TIME ALLOWED: **(2½ HRS)**
INSTRUCTION: ***Answer question 1 and any other four questions***

QUESTION 1

1(a) What are Elementary Particles? [2.5 marks]

(b) Define High energy chambers? [2.5 marks]

(c) List Five (5) examples each of a Gaseous ionization detector and Solid state detector. [5 marks]

(d) List two examples each of elementary particles with half integer spins and hadron family [5 marks]

(e) Define Quack confinement [2 marks]

(f) Draw a table showing Five (5) quark elementary particles families according to their names with the following properties: symbol, charge, and mass [5 marks]

QUESTION 2

2(a) Draw a table showing Five (5) lepton elementary particles families according to their names with the following properties: symbol, antiparticles, charge, and mass [6 marks]

(b) Enumerate three (3) types of Mesons that you know. [3 marks]

(c) Enumerate Six (6) properties of Hyperons elementary particles [3 marks]

QUESTION 3

3(a) List four (4) exact conservation laws of elementary particles [6 marks]
(b) From 3(a) above discuss with examples any two [3 marks]

(c) Test the following reactions and state which ones will occur in nature, also identify the laws violated by any reaction that will not occur in nature.

(i) $p + n \rightarrow p + p + \pi^-$ (ii) $p + n \rightarrow \pi^+ + \pi^0$ [3 marks]

QUESTION 4

4(a) List four (4) types of approximate conservation laws and discuss any two (2) out of the four (4) mentioned. [5 marks]

(b) Use parity transformation to show that the Newton's law of gravitation

$F = \frac{cm_1m_2}{[r_1-r_2]^3}(r_1 - r_2)$ is equal to $m_1\frac{d^2r}{dt^2} = -\frac{cm_1m_2}{[r_1-r_2]^3}(r_1 - r_2)$ [4 marks]

(c) Define the word Interaction and list four different kinds of interaction that you know. [3 marks]

QUESTION 5

5 (a) (i) Differentiate with examples in a symbol form between charged and neutral current reactions in weak interactions. [2 marks]

(ii) From a(i) above, how do charged and neutral current reactions differ from the conservation of strangeness quantum number? [2 marks]

(b) (i) Draw a Feynman diagram at the quark level for the decay $\Lambda \rightarrow p + \pi^-$ [2 marks]

(ii) What would be the effect on the decay rate if nature were to double the weak coupling constant and decrease the mass of the *W* boson by a factor of four? [2 marks]

(c) If the energy spectrum for the electrons emitted in muon decay is given by

$$\frac{dw}{dE_e} = \frac{2G_F^2\left(m_\mu c^2\right)E_e^2}{(2\pi)^3(\hbar c)^6}\left(1-\frac{4E_e}{3m_\mu c^2}\right).$$

What is the most probable energy for the electron and obtain an expression for the total decay width of the muon? [4 marks]

QUESTION 6

Q6. (a) Use lepton universality and quark symmetry to estimate the branching ratio for the decays $b \rightarrow c + e^- + \nu_e$ (where all symbols have their usual meaning) [5 marks]

(b) Use lepton universality and quark symmetry to estimate the branching ratio for the decays $\tau^- \rightarrow e^- + \overline{\nu}_e + \nu_\tau$ (where all symbols have their usual meaning). [4 marks]

(c) Using Feynman diagram explain why the decay $D^o \rightarrow K^- + \pi^+ + \nu_e$ can occur as a charged – current weak interaction at the lowest order [3 marks]