2024
M.Sc.
Second Semester
CORE – 07
PHYSICS
Course Code: MPHC 2.31
(Nuclear & Particle Physics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) If there is exchange of both space coordinates and spin in an interaction, identify the nature of potential for 1d and 3d. 3
   (b) Discuss the characteristic properties of deuteron . 5
   (c) Show that the angle between the neutron and the proton after scattering in the *L*-system is always 90°. 6

2. (a) Estimate the radius of hydrogen ${}^{1}_{1}H$, if the measured radius of Lithium ${}^{8}_{3}Li$ was found to be 2.4 fm. 2
   (b) Show that nuclear interaction is highly charge dependent. 4
   (c) Discuss meson theory of nuclear forces. 8

UNIT–II

3. (a) Write the selection rule for allowed as well as 1st forbidden for both Fermi and Gamow-Teller type. 2
   (b) Do a theoretical calculation from Fermi theory for the detection of neutrino's masses. 6
   (c) Discuss the experiment carried out by F. Reines and C.L. Cowan for neutrino detection. 6

4. (a) Write two examples undergoing gamma decay. 2
   (b) Calculate the energetics of β^+ and β^- decays. 4

(c) Explain the selection rule for gamma emission. Also, discuss briefly the probability of electric field (E) and magnetic field (M). 6+2=8

UNIT–III

5. (a) Explain compound nucleus theory with experimental evidence. 6
   (b) Implement partial wave method for calculating cross-section. 8

6. (a) Estimate the kinetic energy expression for the projectile particle in a direct reaction assuming there is no excitation energy. 6
   (b) Explain the statistical theory of nuclear reaction. 8

UNIT–IV

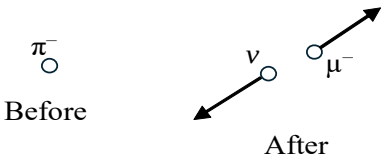
7. (a) Explain Fermi gas model. 6
   (b) Discuss Hartee-Fock self-consistency field. 8

8. (a) The binding energy of a nucleus is approximated by the formula $B.E = a_1 A - a_2 A^{2/3} - a_3 Z^2 A^{-1/3} - a_4 (A-2Z)\,A^{-1}$, where Z is the atomic number and A is the mass number of the nucleus.

   If $\frac{a_4}{a_3} = 30$, find the most stable isobar of the atomic number Z for a given A. 4
   (b) Discuss the smoothing procedure for shell correction using Strutinski method. 4
   (c) Elaborate multipole deformation and briefly discuss rotation of axially asymmetric nuclei. 6

UNIT–V

9. (a) Explain eight-fold way and quark model. 6
   (b) A pion at rest decays into a muon and a neutrino as shown below. What is the speed of the muon? 8



10. (a) Write a note on unification scheme. 4

(b) Briefly discuss TCP theorem. 4

(c) Explain in detail quantum chromodynamics (QCD). 6
