2023

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) Discuss strong spin-orbit interaction between nucleon. 7
   (b) For a given point charge outside the nucleus, derive the expression for nuclear quadrupole moment. 7

2. (a) Approximate what value of angular momentum contributes during low energy scattering. 6
   (b) Estimate the depth and size of square well potential. 8

UNIT–II

3. (a) Discuss the pair production process during gamma energy interaction with matters. 4
   (b) Explain in detail the Fermi theory of beta decay and Kurie plot. How is mass of neutrino detected? 10

4. (a) Write down four properties of neutrinos. 2
   (b) Why are β-particles of energy 5.5 MeV not observed experimentally for $I_i = 4$ and $I_f = 0$? 4
   (c) What are the expected types of gamma ray transitions between the following states of odd atomic mass nuclei:
   $g_{9/2} \rightarrow p_{1/2}, f_{5/2} \rightarrow p_{3/2}, h_{11/2} \rightarrow d_{5/2}, h_{11/2} \rightarrow d_{3/2}$? 8

UNIT–III

5. (a) Discuss Ghoshal's experiment to verify compound nucleus. 7
   (b) Derive the expression for density of state per unit internal energy as a function of energy. 7

6. (a) Write a note on scattering matrix. 6
   (b) Explain Bohr's compound nucleus theory in detail. 8

UNIT–IV

7. (a) Using the semi-empirical formula, calculate the binding energy of $^{40}_{20}Ca$. 4
   (b) How deformed shells are smoothened by Strutinski method? 10

8. (a) Explain the energy levels in a deformed shell model. 7
   (b) Write a note on Hartree-Fock approximation for two electrons system. How do we find the Hartree-fock wave function? 7

UNIT–V

9. (a) Write the interactions which allows the following processes:
   (i) $\pi^+ \rightarrow e^+ + \nu_e$ (ii) $\pi^+ + p \rightarrow n + \pi^+ + \pi^+$ 4
   (b) Write a short note on charge conjugation. 4
   (c) Explain baryon and meson octet. 6

10. (a) Two lumps of clay, each of mass *m*, collide head-on with same velocity $\frac{2}{5}$ C. They stick together. What is the mass *M* of the final composite lump? 4
   (b) Explain in detail quantum electrodynamics (QED) and quantum chromodynamics (QCD). 10