

2022
M.Sc.
Second Semester
 CORE – 07
PHYSICS
Course Code: MPHC 2.31
 (Nuclear & Particle Physics)

Total Mark: 70
Time: 3 hours

Pass Mark: 28

Answer five questions, taking one from each unit.

UNIT-I

1. (a) Discuss the disparity in the value of cross-section of singlet and triplet states. 6
- (b) For a given point charge outside the nucleus, derive the expression for nuclear quadrupole moment. 8

2. (a) Estimate the radius of hydrogen ${}^1_1\text{H}$ if the measured radius of lithium ${}^8_3\text{Li}$ is found to be 2.4 fm. 4
- (b) Highlight the main properties of deuteron and hence estimate the depth and size of square well potential. 10

UNIT-II

3. (a) Prove that for Compton scattering at the angle 0° , the recoil electrons are emitted at angle $\frac{\pi}{2}$. 4
- (b) Explain Fermi theory of beta decay in detail. Hence, explain Kurie-plot. Highlight the detection of neutrino's masses through this experiment. 10

4. (a) Why are β -particles of energy 5.5 MeV not observed experimentally for $I_i = 4$ and $I_f = 0$? 4

- (b) What are the expected types of gamma ray transitions between the following odd A-nuclei:

$$g_{9/2} \rightarrow p_{1/2}, f_{5/2} \rightarrow p_{3/2}, h_{11/2} \rightarrow d_{5/2}, h_{11/2} \rightarrow d_{3/2} ? \quad 5$$

- (c) Explain measurement of gamma energies by crystal diffraction method. 5

UNIT-III

5. (a) Write two major differences between compound nucleus and direct reaction. 2
- (b) Discuss the validity of the statistical assumption in the continuum region. 6
- (c) Derive the expression for density of state per unit internal energy as a function of energy. 6
6. (a) Briefly explain the important conservation laws during nuclear reactions. 4
- (b) Explain the formation and decay of a compound nucleus in a single channel and hence obtain Breit-Wigner single resonance level formula. 10

UNIT-IV

7. (a) Calculate the Fermi energy for proton and neutron. 4
- (b) Explain in detail rotational states of deformed even and odd mass number in axially symmetric as well as asymmetric nuclei. 10
8. (a) Using Hartree-Fock approximation, show that one-electron wave equations resemble Schrödinger wave equations. 4
- (b) Discuss the shell correction by Strutinsky method. 10

UNIT-V

9. (a) Check the interactions by which the processes are allowed
- (i) $\pi^+ \rightarrow e^+ + \nu_e$
- (ii) $\pi^+ + p \rightarrow n + \pi^+ + \pi^+$ 4
- (b) Write a short note on quarks. 4
- (c) Explain baryon and meson octet. 6

10. (a) A pion at rest decays into a muon and a neutrino. In this decay process, calculate the speed of the muon? 4
- (b) Explain the position-time of four vectors and arrive at time-like, space-like and light like conditions for the scalar products. 10
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