

M.Sc DEGREE END SEMESTER EXAMINATION- MARCH 2025**SEMESTER 4 : PHYSICS****COURSE : 21P4PHYT14 : NUCLEAR AND PARTICLE PHYSICS***(For Regular - 2023 Admission and Supplementary 2022/2021 Admissions)*

Duration : Three Hours

Max. Weights: 30

PART A**Answer any 8 questions****Weight: 1**

1. List two quantities which are not conserved in nuclear reaction. Give reason. (A, CO 3)
 2. What are Higg's bosons? Describe briefly. (U, CO 5)
 3. Although the net color of protons and neutrons is zero, there is p-p, p-n and n-n attractions is seen within the nucleus. Give reason. (An, CO 1)
 4. Describe Feynman diagram for i) e- -p interaction (electromagnetic) ii) Weak interaction. (Cr, CO 4)
 5. What do you understand by scattering cross section? Give expression for scattering cross section and show that it has the dimension of area. (A, CO 1)
 6. Plot a labeled schematic showing kinematics of nuclear reaction. (U, CO 3)
 7. It is better to avoid taking CT scan on patients (if possible). Give scientific reason. (U, CO 5)
 8. What is helicity? Hence show that neutrino and antineutrino are two different particles. (An, CO 2)
 9. Give angular momentum and parity selection rules in gamma decay. Explain briefly. (An, CO 2)
 10. What is electroweak theory? (A, CO 4)
- (1 x 8 = 8)**

PART B**Answer any 6 questions****Weights: 2**

11. What is electric quadrupole moment of a nucleus? Show that electric quadrupole moment of spherical nucleus is zero. (E, CO 1)
 12. Discuss with examples four different types of nuclear disintegration. (An, CO 3)
 13. Discuss the shape of the wave function in n-p interaction in deuteron and comment on the implications. (An, CO 1)
 14. Plot a graph showing the number of scattered particles from gold foil vs KE of the incident alpha particles (Coloumb scattering). Discuss the slope of the graph. (An, CO 3)
 15. List out different flavors of quarks and state their properties such as rest mass, charge and spin. (A, CO 4)
 16. What are the different processes of beta decay? Show that the negatron (β^- -decay) emission occurs if the mass of the parent atom is greater than the daughter atom. (A, CO 2)
 17. Predict i) ground state spin ii) parities and magnetic moments of $_{11}\text{Na}^{24}$, $_{13}\text{Al}^{27}$, $_{16}\text{S}^{33}$ and $_{18}\text{Ar}^{41}$ (E, CO 2)
 18. It has been found that the relative abundance of even z nuclei in the universe are more than the adjacent odd Z nuclei in the periodic table. Explain the reason. (An, CO 5)
- (2 x 6 = 12)**

PART C
Answer any 2 questions

Weights: 5

19. Present a detailed account of gamma decay (electric and magnetic multipole oscillations with examples). Explain the associated selection rules for angular momentum and parity in gamma decay. (A, CO 2)
 20. Explain the principle of Rutherford backscattering spectroscopy and briefly outline its use in material research. (An, CO 5)
 21. Describe the quantum mechanical treatment of Deuteron. And hence show that a mixing of S and D states are essential to account for the magnetic moment of deuteron. (A, CO 1)
 22. Describe briefly the following intrinsic quantum numbers in connection with elementary particles: (i) charge number (ii) lepton number (iii) baryon number (iv) multiplet number (v) isospin quantum number (vi) hypercharge and (vii) strangeness. Explain with appropriate examples. (An, CO 4)
- (5 x 2 = 10)**

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	Understand the basic properties of the nucleus and the nuclear forces.	U	3, 5, 11, 13, 21	11
CO 2	Understand Major models of the nucleus and the theory behind the nuclear decay process	U	8, 9, 16, 17, 19	11
CO 3	Understand the physics of nuclear reactions	U	1, 6, 12, 14	6
CO 4	Understand the interaction between elementary particles and the conservation	U	4, 10, 15, 22	9
CO 5	Understand Nuclear Astrophysics, nucleosynthesis and basic applications of nuclear physics.	U	2, 7, 18, 20	9

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;