M.Sc. DEGREE EXAMINATION, APRIL 2022
PHYSICS
FOURTH SEMESTER

COURSE : MAJOR CORE
PAPER   : NUCLEAR AND ELEMENTARY PARTICLE PHYSICS
TIME   : 3 HOURS   **MAX.MAKRS : 100**

<div align="center">SECTION A</div>   **(10x3= 30)**

I. ANSWER ALL QUESTIONS

1. Justify why electrons cannot exist inside the nucleus.

2. Write short notes on the parity of nucleus.

3. Mention four important properties of nucleus.

4. List out few similarities between a nucleus and a liquid drop.

5. Elucidate the relationship between the macroscopic cross section and mean free path.

6. Write the Breit-Wigner single level formula and explain the terms.

7. Differentiate Fermions from Bosons.

8. Write short notes on hyperons.

9. What is α-particle spectra?

10. Polonium 212 emits α-particles whose kinetic energy is 10.54 MeV. Determine the α disintegration energy.

<div align="center">SECTION – B</div>   **(5x5= 25)**

II. ANSWER ANY FIVE QUESTIONS

11. Derive an expression for the scattering cross section of the nucleus.

12. Explain the ground state of Deutron.

13. Discuss in detail the Unified model of atomic nucleus.

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14. In the reaction $^{11}_{5}B + {}^{4}_{2}He \rightarrow {}^{14}_{7}N + {}^{1}_{0}n$, the masses of $^{11}_{5}B$, $^{14}_{7}N$ and $^{4}_{2}He$ are 11.01280, 14.00752 and 4.00387 amu respectively. If the incident α particle has a kinetic energy of 5.250 MeV towards $^{11}_{5}B$ which is at rest and the kinetic energy of the product nuclei $^{14}_{7}N$ and $^{1}_{0}n$ are 3.260 and 2.139 MeV respectively, compute the mass of neutron.

15. Write short notes on the types of nuclear reactions.

16. Compare the different types of fundamental interactions.

17. Explain the process of β decay.

SECTION – C   (3x15= 45)

III.ANSWER ANY THREE QUESTIONS

18. Explain in detail the neutron-proton scattering with necessary derivations.

19. Explain shell model with the help of spin orbit interaction.

20. What is nuclear reaction cross section? Explain its geometrical significance and derive an expression for the differential cross section.

21. (i) Explain the conservation of parity, Charge conjugation symmetry, time reversal and CPT.   (6 Marks)

    (ii) Check if the following reactions are allowed or forbidden.   (8 Marks)

        (a) $\pi^- + p \rightarrow n^0 + \pi^0$

        (b) $p + \bar{p} \rightarrow 2\pi^+ + 2\pi^- + 2\pi^0$

        (c) $\Sigma^0 \rightarrow \Lambda^0 + \gamma$

22. (i) Discuss why classical physics fails to explain α decay.   (4 marks)

    (ii) Explain in detail the Gamow's theory of alpha decay   (11 Marks)

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