THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023
(Regular/Improvement/Supplementary)

PHYSICS
FPHY3C10: NUCLEAR AND PARTICLE PHYSICS

Time: 3 Hours   **Maximum Weightage: 30**

Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.

1. Why can't a single nuclear model explain all the properties of the nucleus?

2. What are magic numbers? Why are magic numbers never odd?

3. What is dark current in photomultiplier tubes?

4. Compare the voltage- sensitive type and charge-sensitive type preamplifiers.

5. Explain the functioning of surface barrier detector.

6. Briefly explain quark-gluon interaction.

7. How do hadrons differ from leptone? Explain.

8. What are confined quarks?

(8 × 1 = 8 weightage)

Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.

9. Obtain the ground state properties of deuteron using a square well potential. Explain the observed spin and quadrupole moment of deuteron.

10. Explain the mechanism of production of energy instars and write the carbon-nitrogen cycle in nuclear fusion

11. Explain the working of semiconductor detectors. What are its advantages?

12. Discuss nuclear transformations. Give Fermi theory of β-deacy.

(2 × 5 = 10 weightage)

Part C: Problems. Answer any *four* questions. Each carries *three* weightage.

13. Explain n-n and p-p scattering.

14. Predict the ground state spin and parity of the nuclei: ^{33}S, ^{7}Li, ^{39}K, ^{45}Sc.

15. The first excited state of ^{182}W is 2^{+} and it is 0.1 MeV above the ground state. Estimate the energies of the lowest lying 4^{+} and 6^{+} states of 182 W.

16. What is the distance of closest approach of a 2 MeV proton to a gold nucleus? How does this distance compare with those for an α-particle of the same energy (For gold Z = 79).

17. Explain why each of the following cannot exist according to the quark model. (a) baryon of spin 1. (b) anti baryon of charge $^+2$.

18. Obtain the weight diagram for Baryon decuplet with intrinsic spin +3/2.

19. Allocate the isospin to the strange particles from the following equations.

   (a) $\pi^- + p \dashrightarrow \Lambda^0 + K^0$

   (b) $p + p \dashrightarrow \Lambda^0 + K^+ + p$

   (c) $\pi^+ + n \dashrightarrow \Xi^- + K^+ + K^+$

(4 × 3 = 12 weightage)