D3APH1902 **(2 Pages)** **Name.....**
Reg. No.....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2020
PHYSICS
FPHY3C10: NUCLEAR AND PARTICLE PHYSICS

Time: Three Hours **Maximum Weightage: 30**

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

1. Explain the origin of magnetic dipole moment and electric quadrupole moment of a nucleus.
2. State the important characteristics of nuclear forces.
3. Define scattering cross- section. What is its unit?
4. What are forbidden decays in beta decay?
5. Briefly explain internal conversion process.
6. State the important features of the collective model of the nucleus.
7. What are D-D and D-T reactions?
8. State and explain CPT theorem.

(8 × 1 = 8 weightage)

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

9. Explain the quantum theory of the ground state of deuteron.
10. Discuss the shell model of the nucleus. Show how the spin-orbit interaction of the nucleons explains the magic numbers.
11. With a neat diagram explain the working of a Ge(Li) detector.
12. (i) Describe the fundamental forces in nature, explaining their important features.

    (ii) Describe the different conservation laws involved in elementary particles interaction.

(2 × 5 = 10 weightage)

(P.T.O.)

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

13. The $_{10}Ne^{23}$ decays by beta emission. If the atomic masses of $_{10}Ne^{23}$, $_{11}Na^{23}$ are 22.994466 amu and 22.089770 amu respectively and mass of the electron is 5.4849×10^{-4} amu, calculate the maximum kinetic energy of the emitted electrons.

14. Enumerate the allowed multipoles carried by the gamma rays when a nucleus makes transitions between the following states.
    (i) $g_{7/2} \rightarrow p_{1/2}$ (ii) $f_{5/2} \rightarrow p_{3/2}$

15. Using the semi empirical mass formula estimate the binding energy per nucleon of the nucleus $_{28}Ni^{57}$. Given the coefficients $a_v = 14.1$, $a_s = 13.0$, $a_c = 0.7$, $a_{asy} = 19.0$, all in MeV.

16. A nuclear fission reactor uses U^{235} as fuel and develops energy at the rate of 3MW. Calculate the number of U^{235} atoms undergoing fission per second in the ractor.

17. An alpha particle of energy 5.48 MeV is completely stopped in an ionisation chamber. The energy required to produce an ion pair in the chamber is 35 eV and the capacitance of the chamber is 50 pF. Calculate the pulse height across an external resistance of 1 MΩ.

18. Identify the dominant interactions involved in the following reactions. Give reasons.
    (i) $K^- + p \rightarrow \sum^- + \pi^+$ (ii) $\mu^+ + \mu^- \rightarrow K^- + K^+$ (iii) $\sum^- \rightarrow p + \pi^0$

19. A particle X is a composite state of three quarks u, d and s. Predict the electric charge, spin and strangeness of the composite particle.

(4 × 3 = 12 weightage)