24P307 (Pages: 2) Name: .....

Reg.No: .....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2025

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19PPHY3C10 - NUCLEAR AND PARTICLE PHYSICS

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. What is a tensor potential with regard to nuclear force?
2. What do you mean by comparative half life?
3. Derive an expression for the energy value of a gamma ray.
4. Differentiate between LS coupling and JJ coupling
5. Write a short note on surface barrier detectors.
6. Distinguish between a single channel analyser and multichannel analysers
7. Explain the meson field and show how Yukawa arrived at the concept of a meson?
8. What is parity? Explain its significance.

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Write a short note about low energy neutron-proton scattering and p-p scattering. Explain Effective range theory approximations
10. What is a fission reaction? Give examples. Explain the characteristics of fission and liquid drop model of fusion.
11. With neat diagram explain the basic processes in a scintillation detector and semiconductor detectors.
12. Describe the eight fold way and show how the octet and decuplet of particles can be formed. Explain quark theory as evolved from Eight fold way model.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. Compute the total B.E and B.E/nucleon for
    a) ^{7} Li b) ^{20} Ne c) ^{56} Fe d) ^{235} U

14. Consider the alpha decay reaction, $Po^{210}_{84} \grave{a} Pb^{206}_{82} + He^{4}_{2}$ where atomic masses m(Po)=210.0483 amu, m(Pb) = 206.0386 amu, m(He)= 4.0039 amu, 1 amu = 93141 MeV. Calculate the kinetic energy of the alpha particle in MeV.

15. Classify the following beta decays as (allowed ,firstforbidden,etc) and type (fermi, Gamow-Teller) transitions.
    a) ^{20}Mg(0+) $\grave{a}$ ^{20}Na(0+)
    b) ^{113}Cd(9/2+) $\grave{a}$ ^{113}In(5/2-)
    c) ^{123}Sn(11/2-) $\grave{a}$ ^{123}Sb(7/2+)
    d) ^{124}Sb(3-)$\grave{a}^{124}$Te(3-)
    e) ^{40}K(4-) $\grave{a}$ ^{40}Ar(0+)
    f) ^{12}N(1+)$\grave{a}^{12}$C(0+)

16. The first excited state of the rotational spectrum of the nucleus $^{238}_{92}$ U has an energy 45 keV above the ground state. Calculate the energy of the second excited state in keV.

17. .Estimate the energy released when two deuteron nuclei fuse to form He nucleus. Given that binding energy per nucleon of $^{2}_{1}$ H =1.1 MeV and that of $^{4}_{2}$ He = 7 MeV.

18. Which of the following reactions are allowed and forbidden under the conservation of strangeness, conservation of baryon number and conservation of charge?
    a) $\pi^- + n \rightarrow \Lambda^0 + K^-$
    b) $\pi^+ + n \rightarrow K^0 + K^+$
    c) $\pi^+ + n \rightarrow K^0 + \Sigma^+$
    d) $\pi^+ + n \rightarrow \pi^- + p$

19. Analyse the following reactions according to their quark content.
    a) $K^- + p \rightarrow \Omega^- + K^+ + K^0$
    b) $p + p \rightarrow \pi^+ + \Lambda^0 + K^0$
    c) $K^- + p \rightarrow \Xi^- + K^+$
    d) $\pi^- + n \rightarrow \Delta^- + \pi^0$

(4 × 3 = 12 Weightage)

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