कण भौतिकी में पालन किए जाने वाले शास्त्रीय और क्वाण्टम मूल संरक्षण कानूनों को उदाहरण सहित समझाइए ।

(b) Write Gell-Mann-Okubo mass formula for Baryons and prove that there is a linear relationship between mass of Baryons and hyper charge in case of decuplet symmetry. **6**

बैरियन के लिए गेल-मैन-ओकुबो द्रव्यमान सूत्र लिखिए और साबित कीजिए कि डिक्यूपलेट समरूपता के मामले में बैरियन के द्रव्यमान और हाइपर चार्ज के बीच एक रैखिक संबंध है ।

9. (a) Write the Quark Model. Write any *eight* Baryons and four Mesons in combination of Quarks. **4**

क्वार्क मॉडल लिखिए । क्वार्क के संयोजन में कोई **आठ** बैरियन और चार मेसॉन लिखिए ।

(b) Draw Baryon Octet. **4**

बैरियन ऑक्टेट बनाइए ।

(c) Explain the necessity of introduction of colour quantum number. **2**

रंग क्वांटम संख्या के परिचय की आवश्यकता को स्पष्ट कीजिए ।

(d) Write a short note on SU(2) and SU(3) symmetries. **4**

SU(2) और SU(3) समरूपता पर एक संक्षिप्त टिप्पणी लिखिए ।

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Semi-empirical Mass Formula and draw the Mass Parabolas for Isobaric families with even and odd Mass numbers. **2+8+6=16**

5. (a) Define Q-value and derive an expression for Q-equation in case of a direct nuclear reaction. **6**

(b) If the outgoing part of a partial spherical wave with angular momentum l is changed by η_l and $\eta_l = -1$, then prove that scattering cross-section attains its maximum value. **10**

Unit III

6. (a) Discuss α-decay, write the general expression for α-decay and draw α-spectrum. **3**

(b) Derive an expression for α-disintegration energy. **5**

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M.Sc. EXAMINATION, 2026

(Second Semester)

(Re-appear Only)

PHYSICS

Nuclear and Particle Physics

(2019-20 Onwards for Colleges and 2018-19 Onwards for UTD)

Time : 3 Hours] [*Maximum Marks : 80*

Before answering the question-paper, candidates must ensure that they have been supplied with correct and complete question-paper. No complaint, in this regard will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory. All questions carry equal marks.

1. (i) In case of low energy $n-p$ scattering, define Effective Range and explain it with the help of graph. Also, write the physical significance of sign of Effective Range.

(ii) Using Single particle shell model predict the ground state spin, parity, and magnetic moment of :

(a) $^{33}_{16}S$

(b) $^{41}_{18}Ar$

(iii) What are expected types of multipole/ gamma ray transitions between following states of odd A nuclei :

(a) $f_{7/2}$ to $p_{3/2}$

(b) $i_{11/2}$ to $d_{3/2}$.

(iv) Are the following interactions allowed ? If allowed then write the type of interactions.

(a) $\pi^+ + n \rightarrow \Lambda + K^+$

(b) $\pi^+ + n \rightarrow K^\circ + K^+$ **4×4=16**

Unit I

2. What are possible states of two nucleon system and out of these, which is stable state ? Write experimentally measured physical properties of that system and describe the stable two nucleon system in its ground system considering square well nuclear potential. Hence, prove that the Nuclear Potential is inversely proportional to the square of the range of Nuclear Potential, in a case, when Nuclear Potential is much greater than the binding energy of stable two nucleon system. **1+2+10+3=16**

3. Prove that scattering cross-section for low energy nucleon-nucleon scattering is independent of nuclear potential. **16**

Unit II

4. Write the similarities between charged liquid drop and nucleus. Deduce the expression for

Unit IV

8. (a) Explain the elementary ideas of CP and CPT invariance. **4**

(b) Explain the types of interactions occurring in Particle physics with examples. **6**

(c) On what basis elementary particles can be classified ? Write their classification. **6**

9. (a) Write the Quark Model. Write any *eight* Baryons and four Mesons in combination of Quarks. **5**

(b) Draw Baryon Octet. **4**

(c) Explain the necessity of introduction of colour quantum number. **3**

(f) Write a short note on SU(2) and SU(3) symmetries. **4**

(c) Discuss the Range of α-particles and derive the expression for Range of α-particles in terms of its Kinetic Energy. **6**

(d) Write the empirical relations between the following : **2**

(i) Range of α-particles and Decay constant.

(ii) Kinetic energy of α-particles and Decay constant

7. (a) Discuss the evidence of existence of neutrino and write its properties. **4**

(b) Write the method of detection of neutrino and proof of existence of both neutrino and anti-neutrino. **7**

(c) Explain the process of γ-decay, its selection rules and multipolarity in γ-transitions. **5**