

(4)
Group—D (CO-4) **12**

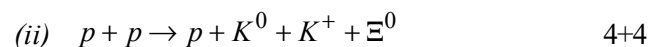
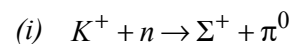
9. Which force binds protons and neutrons inside a stable nucleus and how? Discuss about one of the possible modes of proton neutron interactions using Feynman diagram. 4

(OR)

10. Mention two experimental observations which suggested the possibility of internal structure of hadrons. Give reason in support of your answer. 2+2

11. (a) What are strange particles and what is strangeness quantum number? How is strangeness quantum number related with the charge of the particle? Explain with an example.

- (b) Discuss whether the following interactions are possible. If possible, mention the type of interaction.



(OR)

12. What is weight diagram? Place the members of baryon decuplet (spin-parity 3/2+) in weight diagram and mention the coordinates of each baryon. Determine the quark structure of all non-strange baryons among the members of baryon decuplet. 1+5+2

★ ★ ★

MASTER OF SCIENCE EXAMINATION, 2025

[2nd Year 1st Semester (DAY)]

PHYSICS

PAPER : PHY/TH/110

(Nuclear & Particle Physics)

Time : Two Hours

Full Marks : 40

Group—A (CO-1)

Answer *any one* question :

8

1. (a) Consider a beam of α -particles directed towards a thin gold foil. Derive an expression for the differential cross-section $\frac{d\sigma}{d\Omega}$ for Rutherford scattering of the α -particles. What does it signify?

- (b) A linear accelerator with a peak accelerating potential of 1.63 MV is connected alternately to a 252 MHz oscillator and is designed for the acceleration of protons to an energy of 80 MeV. If the first drift tube length is 5.5 cm, at what kinetic energy are the protons injected into the LINAC? What is the total number of drift tubes in this accelerator? 5+3

(2)

2. (a) A 5 MeV α -particle is scattered backward by a Pt nucleus ($Z = 78$). Calculate the distance of closest approach of α -particle. [$m_\alpha = 6.644 \times 10^{-27}$ kg]
- (b) Explain the underlying principle of operation of a Betatron. Discuss how the electron's motion is synchronized with the changing magnetic field to maintain its circular trajectory and how energy is imparted to the electron.
- (c) What are the main components of a scintillation detector? Briefly explain its working principle.
- 2+3+3

Group—B (CO-2)

14

3. What is the origin of Coulomb energy term in connection with the semi-empirical mass formula for atomic nucleus? Find its dependence on atomic number and mass number of the nucleus.
- 1+3

(OR)

4. Predominant type of interaction of gamma photons with matter changes as energy of the photons increase. Discuss. What are the possible types of gamma radiation for the following transitions?
- (i) $0^+ \rightarrow 1^-$
- (ii) $2^+ \rightarrow 2^+$
- 2+2

PHY-1255

[Continued]

(3)

5. Decay constant for alpha emitters varies widely. Why? Derive the relevant relation for justifying your answer. What is formation factor in the context of alpha decay?
- 2+6+2

(OR)

6. Why polarized nuclei are required for observing parity violation in beta decay? How was polarization achieved in Wu's experiment? Describe the experiment in brief and explain how violation of parity was demonstrated by the experiment. Discuss the beta selection rules for allowed beta decay process.
- 2+2+4+2

Group—C (CO-3)

Answer *any one* question :

6

7. (a) If the nuclear force is charge independent and a neutron and a proton form a bound state, then why is there no bound state for two neutrons or two protons? What information does this provide on the nucleon-nucleon force?
- (b) Why deuteron is supposed to exist in admixture state of 3S_1 and 3D_1 states?
- (2+1)+3
8. What are the basic features of a compound nuclear reaction? Write down the Breit-Wigner formula for cross-section of a nuclear reaction in the neighbourhood of a single resonance and explain each term using a relevant diagram.
- 2+4

PHY-1255

[Turn Over]