PG Even Semester Examination, May 2025

PHYSICS

(4th Semester)

Course No.: PHYCC-652

(Nuclear and Particle Physics)

Full Marks: 70

Pass Marks: 28

Time: 3 hours

The figures in the right margin indicate full marks for the question.
Answer any five questions selecting one from each unit.

UNIT-I

1. (a) What do you mean by saturation of nuclear forces? How can you conclude that nuclear force has short range? 1+2

   (b) Establish that nuclear force depends on the spins of the particles. 4

   (c) For a deuteron in its ground state, assuming a square well potential find the relation between the range and depth of the potential. Draw the figure of ground state wave function. 6+1

2. (a) Discuss n-p scattering at low energy so that S-wave scattering is dominant and obtain the total scattering cross section. 9

   (b) What is scattering length? Discuss the significance of the sign of scattering length. 2+3

UNIT-II

3. (a) How a nucleus is conceptualized in liquid drop model? Write the similarities between the atomic nucleus and the drop of a liquid. Mention some differences between them. 1+5+2

   (b) Write the semi-empirical mass force explaining various terms in it. 6

4. What is the significance of magic numbers? Discuss the single particle shell model to explain the magic numbers. 2+12

UNIT-III

5. (a) Write notes on any three of the following types of nuclear reactions 3x2

   (i) Elastic scattering

   (ii) Disintegration

   (iii) Radiative capture

   (iv) Spallation reactions

   (b) How electric and magnetic radiations originate in a nucleus? Describe in detail how the elctromagnetic decay process takes place. 2+6

6. (a) Derive Fermi's distribution formula for β-decay. 8

   (b) Describe Wu's experiment to establish parity violation in β-decay. 6

UNIT-IV

7. (a) Give a short account on the classification of elementary particles. 5

   (b) State which of the following processes are allowed and which are forbidden with reasons. 1x5=5

   (i) $\Xi^0 \rightarrow \Sigma^0 + \gamma$

   (ii) $\mu^- + p \rightarrow \Lambda^0 + \nu_\mu$

   (iii) $\Sigma^+ \rightarrow \Lambda^0 + \mu^+ + \nu_\mu$

   (iv) $K^- + d \rightarrow \pi^+ + \Sigma^-$

   (v) $p + \overline{p} \rightarrow \Lambda^0 + \Lambda^0$

   (c) Explain Baryon Decuplet. 4

8. (a) Write briefly on the solar neutrino problem. 7

   (b) Write a short note on neutrino oscillation. 7

UNIT-V

9. Describe the construction and working of proton synchrotron. 14

10. (a) Discuss the effect of nuclear radiation on biological systems. 4

    (b) Discuss the construction and working of any solid state nuclear counter. 10

*****