U.G. 5th Semester Examination-2022

PHYSICS

[HONOURS]

Discipline Specific Elective (DSE)

Course Code : PHY-H-DSE-T-02

(Nuclear and Particle Physics)

Full Marks : 60 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **five** questions : 2×5=10

a) Using baryon number and strangeness number conservation laws, find which of the following reactions is allowed :

i) $\pi^- + p \rightarrow \wedge^0 + K^0$

ii) $\pi^- + p \rightarrow \wedge^0 + \pi^0$

b) What is meant by the cross-section of a nuclear reaction?

c) Using the extreme single shell model, calculate the ground state spin parity of $^{17}_{8}O$.

d) What are Bohr's postulates of the theory of compound nucleus?

[Turn over]

e) Justify that nuclear mass density is independent of mass number.

f) Neutron has no electric charge but has a magnetic moment.—explain.

g) What do you mean by mirror nuclei ? Explain with proper example.

2. Answer any **four** questions: $5\times4=20$

a) Define the 'Binding energy of a nucleus'. Graphically show the variation of Binding Energy per nucleon with mass number A. Explain the constancy of Binding Energy per nucleon for a wide region of A.

b) The distance of closest approach of an α-particle fired towards a nucleus with momentum p is r. Show that the distance of closest approach when the momentum of α-particle is 2p is r/4.

c) Why the nucleus is considered as a liquid drop? What are the merits and demerits of the liquid drop model?

d) Determine the most stable nuclei among the members of isobaric family from the binding energy formula.

e) What is hypercharge (Y)? Draw the hypercharge (Y)-isospin(I_3) diagram to place the members of the baryon decuplet.

f) What is Van-de Graaff generator (Tandem accelerator)? Briefly describe its working principle.

3. Answer any **three** questions: 10×3=30

a) i) What is cyclotron frequency? For a cyclotron operating at an extraction radius R = 0.4 m, and a magnetic field of B = 1.5 T = 1.5×10^4 G, find the frequency of the alternating source needed to accelerate protons.

ii) What is a Synchrotron? What is the difference between cyclotron and synchrotron?

iii) Name the places in India where the following Accelerator facility are available:

a) Tandem accelerator

b) Linear accelerator

c) Cyclotron

d) Synchrotrons. (2+3)+(1+2)+2

b) Briefly explain the principle of ionization chamber with proper diagram. Calculate the ionic mobility of an ion in the ionization chamber. 5+5

c) How charged particles lose their energy in matter? Derive classical Bethe-Block formula for energy loss due to ionization. 2+8

d) Explain the primordial nucleosynthesis phenomenon. Discuss different particle nuclear interaction in primordial nucleosynthesis. How heavier elements were formed in nucleosynthesis? What is Gamow Window? 2+3+3+2

e) i) Define Q value in a nuclear reaction.

ii) What is exoergic and endoergic reaction? Give example.

iii) A projectile of rest mass m_p and kinetic energy T_p collide with a target of mass m_T. If the rest mass of the final particles be m_x, m_R and kinetic energy T_x, T_R respectively, and the scattering angle be θ, derive the expression for Q value. 2+2+6
