

U.G. 5th Semester Examination-2021

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 **ten** questions from the following:

2×10=20

- What is nuclear parity? How will you determine the parity of hydrogen-like atoms?
- Compare atomic magnetic moment and nuclear magnetic moment.
- What are the importance of packing fraction curve?
- Which quantities are not conserved in a nuclear reaction?
- What is Geiger-Nuttal law? Explain.
- Why stable nuclei have more neutrons than protons?

- What is Compton scattering?
- What is the basic principle of a van-de Graaff generator?
- What are stripping and pick-up reactions?
- Indicate the relative strength of the different types of interaction.
- Write down the quark contents of pions.
- What are strange particles?
- What is s- process path?
- Define activity of a radioactive substance. What is its unit?
- What is Bethe-Block formula?

2. Answer any **four** questions from the following:

5×4=20

- What is mirror nuclei? How will you estimate the nuclear size from mirror nuclei method?
2+3
- Mention the properties of neutrino? Explain qualitatively how the hypothesis of a neutrino solves the apparent breakdown of conservation of energy and momentum in β decay. What is internal conversion? Explain. 1+2+2
- Write a short notes on Fermi gas model. 5

d) What is the basic difference between liquid drop model and shell model of the nucleus? What is the evidence for the shell structure of the nuclei?
2+3

e) What do you mean by quarks? Give the charge and quantum number associated with each quark. What are color quantum number and gluons?
1+2+2

f) i) Check if the following reactions are allowed or forbidden:
 $\pi^- + p \rightarrow \Lambda^0 + \pi^0$ and $p + p \rightarrow 2\pi^+ + 2\pi^- + 2\pi^0$
ii) Find the distance of closet of approach of 1 MeV protons incident on gold nuclei.
3+2

3. Answer any **two** questions from the following:
10×2=20

a) i) Write down semi-empirical mass formula explaining the significance of its various terms. Derive an expression for the nuclear charge of the most stable nucleus for a given isobaric family using this formula.
ii) Predict the ground state spin and parity of the following nuclei: ${}_{15}\text{P}^{30}$ and ${}_{29}\text{Cu}^{63}$
(3+3)+(2+2)

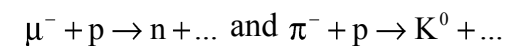
b) i) What is the nature of nuclear force? Explain briefly.

ii) What is Q value of a nuclear reaction? Calculate the Q values of the reaction ${}^3_1\text{H} + {}^2_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n}$
Given: $M({}^3_1\text{H}) = 3.0169982$,
 $M({}^2_1\text{H}) = 2.0147361$, $M({}^4_2\text{He}) = 4.0038727$
and $M({}^1_0\text{n}) = 1.0089832$ all in amu. What is the nature of the reaction?

iii) Define cross-section of reactions and write down its unit.
4+(1+2+1)+2

c) Describe a GM counter and explain its operation. Deduce the expression for the maximum energy of an emerging proton beam in a cyclotron in terms of the radius of the dees and the magnetic field.
(3+3)+4

d) i) A μ^- meson ($m_\mu = 207m_e$) decays into an electron and a pair of neutrinos. Calculate the maximum available energy for the process and the average electron energy.
ii) Identify the unknown particle in the reactions given below, using the conservation laws:



iii) Show that the nature of binding fraction curve is complementary to the nature of the packing fraction curve.

iv) What is isomer? 3+3+3+1
