Roll No. ……..

PHY–551

Nuclear Physics and Analytical Techniques

M.Sc. PHYSICS (MSCPHY-12/13/16/17)

Second Year, Examination, 2018

Time : 3 Hours **Max. Marks : 80**

Note : This paper is of **eighty (80)** marks containing **three (03)** Sections A, B, C. Attempt the questions contained in these Sections according to the detailed instructions given therein.

Section–A

(Long Answer Type Questions)

Note : Section 'A' contains four (04) long answer type questions of nineteen (19) marks each. Learners are required to answer *two* (02) questions only.

1. What are the basic differences between liquid drop model and shell model of the nucleus ? What is the evidence of shell structure in the nuclei ? Explain the main assumptions of the shell model of the nucleus. Discuss its achievements, failures and limitations.
2. Write short notes on any *two* of the following :
   (i) Auger electron
   (ii) Spin-orbit coupling
   (iii) Internal conversion

3. Derive Fermi's four factor formula with significance of each term in the formula. Explain how the Fermi's four factor formula is used in designing a nuclear reactor.
4. Discuss the compound nucleus model of nuclear reactions and explain the Ghoshal experiment.

Section–B

(Short Answer Type Questions)

Note : Section 'B' contains eight (08) short answer type questions of eight (08) marks each. Learners are required to answer *four* (04) questions only.

1. What target isotope must be used to form the compound nucleus $^{24}_{11}\text{Na}$, when the projectile is neutron, proton and alpha particle ?
2. Why is $^3P_1$ not a component of the ground state of the deuteron ?
3. Using SEMF, explain why $^{238}_{92}\text{U}$ nuclide is an α-emitter and not a β-emitter ?
4. Plot the general shape of the binding energy curve (Binding energy per nucleon versus mass number A). Explain fission and fusion on the basis of this plot.
5. Enumerate the salient features of nuclear forces.
6. Write a short note on Pauli hypothesis of $\nu/\bar{\nu}$ in the β-decay.
7. Why is di-neutron not found in the nature ?
8. List all the possible multipole γ-ray transitions between the following pair of nuclear states :

$$5/2^+ \rightarrow 3/2^+$$

Section–C
(Objective Type Questions)

Note : Section 'C' contains ten (10) objective type questions of one (1) mark each. All the questions of this Section are compulsory.

1. When an electron and positron annihilate :
   (a) Two photons are created
   (b) One photon is created
   (c) Nothing is created
   (d) A neutron is created

2. Nuclear fission is explained by :
   (a) LDM
   (b) Shell model
   (c) Collective model
   (d) All of the above

3. The entire kinetic energy of a projectile is ..... for the nuclear reaction to take place.
   (a) Available in the lab system
   (b) Not available in the lab system
   (c) Available in the CM system
   (d) Not available in the CM system

4. Are thermal neutrons mono-energetic ?
   (a) Yes, they have an energy of 0.4 eV
   (b) Yes, they have an energy of 0.25 eV
   (c) Yes, they have an energy of 0.025 eV
   (d) No

5. Discontinuities in the nuclear binding energy curves is best explained by :

   (a) LDM

   (b) Single particle model

   (c) Rotational model

   (d) Vibrational model

6. Radius of $^{165}_{67}$Ho nucleus in f_m is :

   (a) 15.4

   (b) 5.5

   (c) 12.8

   (d) 6.8

7. During negative beta decay :

   (a) An atomic electron is ejected

   (b) An electron which is already present within the nucleus is ejected

   (c) A neutron in the nucleus decays emitting an electron

   (d) None of these

8. Which of the following is NOT conserved in nuclear reactions ?

   (a) Magnetic dipole moment

   (b) Baryon number

   (c) Statistics

   (d) Angular momentum

9. The half-life of a radioactive substance depends upon :
   (a) Its temperature
   (b) The external pressure on it
   (c) The mass of the substance
   (d) None of these

10. Which of the following statements is INCORRECT for the nuclear force between two nucleons ?
   (a) It is charge independent
   (b) It is spin independent
   (c) It is velocity dependent
   (d) It has non-central component