Reg. No. | | | | | | | | | |

PHS 555

IV Semester M.Sc. Degree Examination, September/October 2022
(CBCS)
PHYSICS
Nuclear Physics – III

Time : 3 Hours Max. Marks : 70

***Instructions** : Answer **any four full** questions choosing **one** from each Part – **I** to **IV**. Part – **V** is **compulsory**.*

PART – I

1. a) Discuss the Fermi gas model of a nucleus and obtain the expressions for Fermi energy of neutrons and protons and hence the total kinetic energy for the ground state.

   b) Write a note on nuclear evaporation. **(12+3)**

2. a) Obtain the energy levels of nucleus based on the harmonic oscillator potential. Explain how the spin-orbit interaction helps to reproduce the magic numbers of nuclei.

   b) Write a note on shell model prediction of quadrupole moments of nuclei. **(12+3)**

PART – II

3. a) Discuss the motion of two nucleons outside the core of ^{18}O nucleus by assuming the two neutrons are in $d_{5/2}$ and ($d_{5/2}$-$S_{5/2}$) orbits.

   b) Explain Nordheim's rule for odd-odd nuclei. **(12+3)**

4. a) Explain the inadequacies of the shell model, which motivated the collective model of a nucleus.

   b) Discuss the motion of a nucleon in a deformed potential based on the Nilsson model. Explain the significance of the Nilsson diagrams. **(5+10)**

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PART – III

5. a) Give the features of direct reaction model and compound nucleus model.

   b) Discuss the significance of complex potential in optical model. Show that, the mean free path is inversely proportional to the strength of the imaginary potential of the optical model. **(5+10)**

6. a) By using the method of partial wave analysis, obtain the expression for nuclear reaction and scattering cross sections. Show that, there is no reaction without scattering. **15**

PART – IV

7. a) Using perturbation theory, obtain an expression for determining the nuclear reaction cross section.

   b) Discuss the principle of detailed balance for nuclear reactions. Show that it can be used to measure the spin of the pion. **(9+6)**

8. a) Describe the various features of PWBA. Illustrate its predictions of angular momentum.

   b) Briefly explain the modifications introduced in the DWBA. **(11+4)**

PART – V

9. Answer **any two** of the following. **(2×5=10)**

   a) Calculate the ground state spin and parity of ^{37}Cl and ^{63}Cu nuclei.

   b) If the energy of the first excited rotational state of an even-even nucleus is 0.32 MeV and its spin is 2^+, find the energies corresponding to 4^+, 6^+ and 8^+ states.

   c) If a nucleon of few MeV energy that corresponds to a velocity of $\approx 5 \times 10^7$ m/s travels through the target nucleus and results in the formation of compound nucleus, estimate the life time of the compound nucleus. Given : Size of the nucleus is 2×10^{-15} m and number of collisions suffered is 10^7.

   d) What is meant by spectroscopic factors ? Explain.

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