(i) Printed Pages: 3 Roll No. .....

(ii) Questions : 9 Sub. Code : 3724

Exam. Code : 0475

M.Sc. Physics 4th Semester

(2053)

NUCLEAR PHYSICS—II

Paper : PHY–8044

Time Allowed : Three Hours] [Maximum Marks : 80

**Note :**—Attempt **FIVE** questions in all, selecting **ONE** question each from Units I to IV. Question No. **9** from Unit V is compulsory to attempt.

## UNIT—I

1. (a) Prove that energy shift due to spin-orbit potential in the shell model increases with the values of orbital angular momentum '$\ell$'. 9

   (b) Calculate the coupled state and corresponding C.G. coefficients for two particles with $j_1 = j_2 = \frac{1}{2}$. 7

2. (a) Discuss the Russell-Saunder's Coupling (LS-Coupling) and j–j Coupling Schemes. 9

   (b) Determine the Harmonic Oscillator frequencies 'ω' appropriate to the nuclei $^{17}O$ and $^{60}Ni$. 7

## UNIT—II

3. (a) What are various collective surface fluctuations ? Also, mention the processes associated with these fluctuations. 8

(b) Prove that the energies of nuclear vibrational level with one phonon ($\lambda = 3$) is equal to the energy of 2-phonon with ($\lambda = 2$). 8

4. (a) What is Nuclear Rotational Motion ? Derive the rotational energy spectra and nuclear wave function for an odd-A nuclei. 8

(b) Define Rotation Matrix and explain how the rotation about an arbitrary axis 'X' can be expressed in terms of Euler's angles of rotations. 8

## UNIT—III

5. (a) What is optical model ? Derive theoretical cross-sections with the optical model and compare it with experimental value. 8

(b) Derive the Breit-Wigner Dispersion formula. 8

6. (a) What are stripping and pick-up reactions ? Explain with examples. Obtain the relation for pick-up cross-section in terms of relative momenta of incoming and outgoing particles. 8

(b) Discuss the statistical model for the theory of a compound nucleus. Derive the evaporation probability and cross-section for specific reactions. Also, discuss the basic properties of direct and compound nuclear formation. 8

## UNIT—IV

7. (a) Explain the features of Nillson model and obtain the deformed Hamiltonian for the same. How it differs from Standard Shell model ? 8

   (b) Write and explain the phenomenon of Back-bending in detail. 8

8. (a) Describe Cranking model and give its salient features. Compare this model with Nillson model. 8

   (b) Write a brief note on the kinematics and dynamical moment of Inertia. 8

## UNIT—V

9. (a) Write down the shell configuration for $_{30}Zn^{67}$ and $_{43}Tc^{99}$.

   (b) What do you mean by Nuclear halos ?

   (c) What is iso-scalar vibrations ?

   (d) What is difference between single particle, extreme particle and independent shell models ?

   (e) In what situation statistical model can be used for fusion ?

   (f) What is difference between rotational and vibrational nucleus ?

   (g) What is Nordheim's rule ?

   (h) Define seniority quantum numbers. 8×2=16