M.Sc. Physics 4th Semester

(2054)

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. Unit-V is compulsory to attempt.

UNIT—I

1. (a) Define Racah coefficient and state its symmetry properties. How is it related to 6-j Symbol ?   8

    (b) Determine harmonic oscillator frequencies 'ω' appropriate to the nuclei ^{17}O and ^{60}Ni. Also write the shell configurations for $_{30}Zn^{67}$ and $_{43}Tc^{99}$.   8

2. (a) Prove that energy shift due to spin-orbit potential in the shell model increases with l-values. Also describe the success and failure of this model.   8

    (b) Calculate the coupled state and corresponding C.G coefficients for two particles with $J_1 = J_2 = 1/2$.   8

UNIT—II

3. (a) Describe the parameterization of nuclear surface. How the quadrupole deformation is represented in different co-ordinate system ? For quadrupole deformation, describe nuclear shapes in principle axis system as a function of γ for a fixed β. 8

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

4. (a) What is nuclear Rotational motion ? Derive Rotational energy spectra and nuclear wave function for even-2 nuclei. 8

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

UNIT—III

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

 (b) What is the basis of optical Model used in heavy ion fusion ? 8

6. (a) Explain, why one needs statistical theory for compound nuclei. Discuss Statistical Model for the theory of compound nucleus and derive the evaporation probability and cross-section for a specific reaction. 8

 (b) Explain Breit-Wigner Resonance Dispersion formula. 8

7. (a) Explain the features of Nilsson-Model and obtain the deformed Hamiltonian for the same. How it differs from shell-model ?   8

   (b) Explain the kinematics and dynamical moment of inertia. 8

8. (a) Explain and derive the Cranking Shell Model and give its salient features. Compare this model with Nilisson model.   8

   (b) Explain the phenomenon of Back-Bending.   8

UNIT—V

9. (a) Define and explain Seniority quantum number.

   (b) Write a note on configuration mixing.

   (c) Write a short note on electric quadrupole moment.

   (d) What do mean by Nuclear halos ?

   (e) What is iso-scalar vibrations ?

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

   (g) What are "Giant resonances" ?

   (h) What are nuclear shock waves ? $8 \times 2 = 16$