M.Sc. Physics 3rd Semester

(1129)

NUCLEAR PHYSICS—II

Paper—PHY-7003

Time Allowed : Three Hours]   **[Maximum Marks : 60**

Note :— Attempt *five* questions in all, selecting *one* question each from Units (I-IV). Q. No. **9** from Unit-V is compulsory to attempt.

UNIT—I

1. (a) Discuss the shell model based on harmonic oscillators potential. Also show how Bessel's function can lead to few magic numbers.   6

    (b) Calculate the coupled state and corresponding C.G. coefficients for two particles with $j_1 = 1$ and $j_2 = \frac{1}{2}$.   6

2. (a) Discuss the shell model based on square-well potentials of infinite depth. How the inclusion of spin-orbit coupling term modifies the energy level diagram ?   7

    (b) Define Racah coefficients. Deduce the expression for Wigner 9j-symbols.   5

UNIT—II

3. (a) What is nuclear rotational motion ? Derive rotational energy spectra and nuclear wave functions for an odd-A nuclei and even-2 nucleus. 7

   (b) What is D-matrix ? Derive the expression for Clebsch-Gordon (C.G.) series of D-matrix. 5

4. (a) Write a note on β and γ vibrations in spheroidal nucleus. 5

   (b) Explain the vibrational energy spectrum of an odd-A nuclei. Obtain the derivation for the collective hamiltonian. 7

UNIT—III

5. (a) Discuss the theory of compound nucleus formation in the region where separated levels exists. Derive the expression for the width of Resonance $\Gamma_{sc,o}$ and $\Gamma_{r,o}$. 6

   (b) Explain the kinematics of stripping and pick-up reaction. 6

6. (a) Explain various types of nuclear reactions depending upon product nuclei. Explain with examples. What are nuclear reaction kinematics ? 6

   (b) What is nuclear cross-section ? Define partial and differential cross-section. Explain classical analysis of cross-section. 6

7. (a) What are salient features of Nilsson model ? How it differs from standard shell model ? 6

(b) Write a brief note on the kinematics and dynamical moment of inertia. 6

8. (a) Describe cranking model and give its salient features. 6

(b) Write a short note on back-bending phenomenon. 6

UNIT—V

9. (a) What do you mean by vibrational nucleus and rotational nucleus ?

(b) Why Briet-Wigner formula is called dispersion formula ?

(c) Define GMR, GDR and GQR.

(d) What are nuclear shock waves ?

(e) What is super heavy element ? Describe in brief its experimental method for its production.

(f) Using single particle shell model, predict the ground state spin and parity of $_{13}Al^{27}$ and $_{16}S^{33}$. 6×2=12