M.Sc. DEGREE END SEMESTER EXAMINATION- MARCH 2026
SEMESTER 4 : PHYSICS
COURSE : **21P4PHYT13 : ATOMIC AND MOLECULAR PHYSICS**
(For Supplementary 2023/2022/2021 Admissions)

Time : Three Hours   Max. Weights: 30

PART A
Answer any 8 questions   **Weight: 1**

1. Why does Stark effect lift degeneracy of electronic levels only partially?   (U, CO 1)

2. Explain the principle of ESR   (U, CO 4)

3. The first line in the P branch is numbered as P_1 where as the first line in the R branch is R_0. Explain.   (A, CO 2)

4. Give examples of prolate and oblate symmetric top molecules.   (A, CO 2)

5. List the different types of electron microscopes used in material charactirization   (R, CO 5)

6. How hyper fine structure is obtained in atomic spectra?   (U, CO 1)

7. What is meant by spin lattice relaxation?   (U, CO 4)

8. What is the effect of centre of symmetry on the spacing of rotational Raman lines?   (An, CO 3)

9. What are the principal differences between electron and scanning probe microscopies?   (U, CO 5)

10. Distinguish between Raman Scattering and Rayleigh scattering.   (An, CO 3)

(1 x 8 = 8)

PART B
Answer any 6 questions   **Weights: 2**

11. Briefly discuss the effect of isotopic substitution on the rotational spectra of molecules.   (A, CO 2)

12. Calculate the recoil velocity of a free Mossbauer nucleus of mass 1.67×10^{-25} kg, when emitting a gamma ray of wave length 0.1nm.   (A, CO 4)

13. Write short note on the scattered electrons in SEM technique.   (Cr, CO 5)

14. Evaluate Lande's g factor for $^2F_{7/2}$ state.   (A, CO 1)

15. What information can be derived from the Raman spectroscopic studies?   (An, CO 3)

16. An NMR instrument operates at 30.256MHz. What magnetic field is required to bring a ^{13}C nucleus to resonate at this frequency? μ_N for carbon is 0.7022.   (A, CO 4)

17. Rotational Raman spectra of certain molecules show alternation of intensities and in certain molecules, the spacing is double than the expected. Explain with examples.   (A, CO 3)

18. The ground state of chlorine is $^2P_{3/2}$. (a) Find its magnetic moment.(b) In to how many sub states will the ground state split in a weak magnetic field?   (A, CO 1)

(2 x 6 = 12)

PART C
Answer any 2 questions   Weights: 5

19.	with a neat diagram explain the functioning of a Confocal Microscopce	(E, CO 5)
20.	Explain band head and band origin in relation to the rotational fine structure of electronic vibration spectra.	(A, CO 3)
21.	Describe the microwave spectra of a diatomic molecule considering it as a non rigid rotator.	(A, CO 2)
22.	Describe spin orbit interaction. Explain the doublet formation of sodium D lines on the basis of spin orbit interaction.	(A, CO 1)

(5 x 2 = 10)

OBE: Questions to Course Outcome Mapping

CO	Course Outcome Description	CL	Questions	Total Wt.
CO 1	To apply the principles of atomic spectroscopy in the study of material science	A	1, 6, 14, 18, 22	11
CO 2	Analyse the microwave and infra red spectrum in the material science study	An	3, 4, 11, 21	9
CO 3	Analyse the given Raman & UV - Visible spectra in the material science study	An	8, 10, 15, 17, 20	11
CO 4	To understand about the NMR, ESR & Mossbauer technique of material identification	U	2, 7, 12, 16	6
CO 5	Understand about the advanced spectroscopic techniques	U	5, 9, 13, 19	9

Cognitive Level (CL): Cr - CREATE; E - EVALUATE; An - ANALYZE; A - APPLY; U - UNDERSTAND; R - REMEMBER;