Name: Enrolment No:	

UPES

End Semester Examination, December 2024

Programme Name: Integrated BSc-MSc (Physics) **Semester:** VII
Course Name: Atomic & Molecular Physics **Time:** 3 hrs
Course Code: PHYS4001 **Max.** Marks: 100
No. of pages: 2

Instructions: As instructed in each section. Symbols have their usual meanings.

SECTION A

(Answer all the questions: 5 Qs × 4 M = 20 Marks)

S. No.		Marks	CO
Q 1	In a tabular form write down the differences between 3-level laser and 4-level laser.	4	CO1
Q 2	Identify which molecules are rotational active: (a) H_2, (b) CO_2, (c) H_2O, (d) CCl_4	4	CO1
Q 3	Sketch space quantization of **J** for the $4^2P_{3/2}$ state.	4	CO2
Q 4	A vibrational level is observed at 2900 cm^{-1} for HCl molecule. Estimate the force constant k (consider, atomic mass unit = 1.677×10^{-27} kg).	4	CO3
Q 5	Compute free space electric and magnetic fields associated with a He-Ne laser of intensity 15 W/m^2.	4	CO4

SECTION B

(Answer all the questions: 4 Qs × 10 M = 40 Marks)

Q 6	What is population inversion? Discuss details of how population is achieved in 3-level and 4-level laser with the help of suitable diagrams.	10	CO1
Q 7	Describe construction and working of solid state laser (ruby laser).	10	CO2
Q 8	Calculate observed line frequencies for the atoms placed in 5.25 Tesla magnetic field. The fundamental line frequency is 600×10^{12} Hz.	10	CO2
Q 9	Discuss Paschen-Back effect. **OR** Discuss anomalous Zeeman effect.	10	CO3

SECTION C (Answer all the questions: 2 Qs × 20 M = 40 Marks)			
Q 10	(a) Show that Einstein co-efficients A and B are related to each other in the following form, $A_{21} = \frac{8\pi h\nu^3}{c^3} B_{21}$, and $B_{12} = B_{21}$	10	CO3
	(b) A rotational structure of diatomic molecule shows microwave absorption with rotational constant B = 12 cm^{-1}. Compute moment of inertia (I) of the diatomic molecule.	10	CO4
Q 11	(a) Deduce the expression for magnetic moment (μ) originating due to orbital motion of electron.	10	CO3
	(b) Analyse, P, R and Q branches of vibrational-rotational spectra of diatomic molecule.	10	CO4
	OR		
	(a) Write short note on E.S.R.	10	CO3
	(b) Calculate 'g' *and* 'gm_j' and magnetic moment for the state, $3^2P_{3/2}$.	10	CO4