Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Atomic, molecular and laser physics **Semester: II**
Program: Time: 03 hrs. **Max. Marks: 100**
Course Code: PHYS7022

Instructions: • All the questions of section-A are compulsory
• Section-B and Section-C have internal choice

SECTION-A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q1	A laser beam (λ = 600 nm) has coherence length L_c = 10 cm, calculate spectral purity ($\Delta\lambda$).	**4**	**CO1**
Q2	Tabulate the basic differences between E.S.R and N.M.R.	**4**	**CO1**
Q3	Sketch space quantization of total angular momentum vector **J** for the given state, $4^2P_{5/2}$	**4**	**CO2**
Q4	Differentiate population inversion in 3-level and 4-level laser systems.	**4**	**CO2**
Q5	Calculate electric and magnetic field strength of a laser beam whose intensity is 2.5 kW/m^2.	**4**	**CO3**

SECTION-B
(4Qx10M= 40 Marks)

Q6	Calculate loss co-efficient α (dB/KM) for the laser that travels 2 KM. Assume output to input power ratio = 0.5.	**10**	**CO1**
Q7	Deduce the expression for magnetic moment (μ) originating due to orbital motion of electron.	**10**	**CO2**
Q8	Compare the rotational energy levels separation due to isotopic effect using a neat level diagram.	**10**	**CO2**

Q9	A rotational spectrum of diatomic molecule shows 1st microwave absorption at, $\bar{v}=3.85\,cm^{-1}\wedge 3.68\,cm^{-1}$ for $^{12}C^{16}O$ and its isotope $^{m}C^{16}O$. Calculate mass number m. **OR** Energy difference between two consecutive vibrational levels appears to be 400 meV. Compute the corresponding emitted wavenumber.	**10**	**CO3**
	SECTION-C **(2Qx20M=40 Marks)**		
Q10	(a) A Zeeman splitting occurs at 10 Tesla of magnetic field. Calculate frequency shift, $\Delta\nu$. (b) According to Franck-Condon principle depict Morse curve for electronic-vibrational transitions when equilibrium position of upper state is shifted towards high or low, or remains same as that of ground state.	**10** **10**	**CO1** **CO2**
Q11	(a) Analyse the working of Ruby laser with a clear diagram. (b) Deduce the relation between the Einstein co-efficient A and B by discussing stimulated absorption, spontaneous emission and stimulated emission. **OR** (a) Discuss 3-level laser system with energy levels. Analyse why the threshold energy required is relatively less than that of 2-level laser system? (b) Show that to achieve laser the resonant cavity length L must take the form, $L=\frac{1}{2¿¿}$ where, ɣ = threshold gain, α =loss coefficient, r_1 and r_2 are the reflection co-efficient of partially and 100% reflecting mirrors, respectively.	**10** **10** **10** **10**	**CO3** **CO3** **CO3** **CO3**