

M.Sc. 3rd Semester Examination, 2011**PHYSICS**

PAPER—PHS-302 (A & B)

*Full Marks : 40**Time : 2 hours***Answer Q. No. 1 and any one from the rest***The figures in the right-hand margin indicate marks**Candidates are required to give their answers in their own words as far as practicable**Illustrate the answers wherever necessary***Use separate script for Gr. A and B**

PAPER — PHS-302 A

[Marks : 20]

1. Answer any *four* questions : $2\frac{1}{2} \times 4$

- (a) In a He—Ne laser transition from $3S \rightarrow 2P$ level gives a laser emission of $\lambda = 632.8 \text{ nm}$. If the $2P$ level has energy $15.2 \times 10^{-19} \text{ J}$, calculate the pumping energy required, assuming no loss.

(Turn Over)

- (b) Calculate the ratio of stimulated to spontaneous emission rates for the wavelength $\lambda = 5893 \text{ \AA}$ at 200°C .
- (c) The energy-gap between two levels corresponds to wavelength $\lambda = 5000 \text{ \AA}$. Find the ratio of population of the two states in thermal equilibrium at room temperature.
- (d) HCl has a B value of 10.593 cm^{-1} and a centrifugal distortion constant D of $5.3 \times 10^{-4} \text{ cm}^{-1}$. Estimate the vibrational frequency and force constant of the molecule.

$${}^1\text{H} = 1.673 \times 10^{-27} \text{ kg};$$

$${}^{35}\text{Cl} = 58.06 \times 10^{-27} \text{ kg};$$

$$C = 2.998 \times 10^8 \text{ mS}^{-1}.$$

- (e) Write Born-Oppenheimer approximation in case of molecular vibrational, rotational and electronic spectroscopy. Write also its application in molecular spectroscopy.
- (f) Why does a spherical symmetric molecule is microwave inactive? Give an example of such type of molecule.

2. What is a three level laser system ? Obtaining the rate equations of each of the energy levels, find the expression of population inversion in the system ? Obtain also the expression of its threshold power. Give an example of three level laser. $2 + (3 + 2) + 2 + 1$
3. (a) What do you mean by an asymmetric top molecule ? Write an example.
- (b) By the observation of microwave spectroscopy, how can you find the interatomic separation of a triatomic linear molecule ?
- (c) Compare the rotational constants of CO and CO₂. Which of them is microwave active ? $(1 + 1) + 5(2 + 1)$

PAPER – PHS-302 B

[Marks : 20]

1. Answer any *four* questions : $2\frac{1}{2} \times 4$
- (a) What are virtual and real images in relation to the reconstruction of the image from a hologram ?

- (b) What is a graded-index fibre ? Discuss its advantages over a step-index one.
- (c) In a graded-index fibre the radial distribution of index is given by $n(r) = 1.52 - 2r^2$ with r in mm up to a radius $r_0 = 0.2$ mm. Calculate the acceptance angle of the fibre.
- (d) What do you mean by "self-focussing phenomena" ?
- (e) Construct a tri-state 'AND' logic gate and show its truth table.
- (f) Show that the refractive index of a nonlinear material depends on the intensity of the incident light.
2. What is intermodal dispersion in a step-index optical fibre ? Derive its expression for a step-index optical fibre. A step-index fibre has a core of index 1.5 and a cladding of index 1.489. Find the temporal broadening of a pulse in nano-second per kilometre. Also, find the spread in space

for 1 km of the fibre. What are the advantages and disadvantages of optical fibre communication over the conventional communication system using wires ?

1 + 3 + 3 + (2 + 1)

3. What are the advantages of parallel processing ? Show how can you obtain all optical XOR and AND gates in practice. Derive an expression to determine self focusing length in a nonlinear material. Construct an opto-electronic AND and XOR gate.

1 + 3 + 4 + 2

