

**2009**

**M.Sc.**

**3rd SEMESTER EXAMINATION**

**PHYSICS**

**PAPER—PH-2102**

**Full Marks : 40**

**Time : 2 Hours**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

*Illustrate the answers wherever necessary.*

**Module—PH-2102A**

**(Spectroscopy and Laser Physics)**

**(Marks : 20)**

**Answer Q. No. 1 and any one from the rest.**

**1. Answer any four :**

**$2\frac{1}{2} \times 4$**

- (a) What are the advantages of four level laser over three level laser ?
- (b) What do you mean by Q-switching in laser radiation ?

- (c) Why vibrational spectra is associated in the near infra-red region ?
- (d) Write down Born-Oppenheimer approximation and explain it.
- (e) HCl molecule shows a strong absorption line at wavelength  $3.56\mu$ . Assuming origin of the line due to vibration, calculate the force constant for HCl bond.
- (f) What do you mean by band head in molecular electronic spectroscopy ?
2. Outline the theory of diatomic molecule as a non-rigid rotator and anharmonic oscillator & hence clearly indicate the different branches. 10
3. (a) Which of the following molecules will show a microwave rotational spectrum —  $H_2$ , HCl, and  $CH_4$  ? Justify your answer. 3
- (b) Write the expression of quantised rotational energy values of a polyatomic linear rotator. 1
- (c) How the interatomic separations of  $CO_2$  molecule could be known by isotropic substitution mechanism ? 4
- (d) The fundamental bond of CO is centred at  $2143.3\text{ cm}^{-1}$  and first overtone at  $2459.7\text{ cm}^{-1}$ . Calculate the equilibrium frequency of the molecule. 2

**Module-PH-2102B****(Photonics)****(Marks : 20)**

Answer Q. No. 1 and any one from the rest.

1. Answer any four bits :  $2\frac{1}{2} \times 4$
- (a) Explain index ellipsoid.
  - (b) Why does population inversion not achieved in a two-level laser system ?
  - (c) Discuss the necessity of coherent light for production of a hologram.
  - (d) With supporting figure discuss the operation of an optical/opto-electronic EX-OR logic gate.
  - (e) Explain tristate number mentioning the necessity of it.
  - (f) An optical fibre may be regarded as a waveguide — explain.
2. (a) What is a three level laser system ? Write the example of a three level laser system. 2+1
- (b) Obtain the expression of population inversion equation of a three level laser system. 4
  - (c) Find also the expression of threshold power required in a three level laser for lasing action. 3

3. (i) Prove that the fraction of light collected by an optical fibre from a source depends upon the numerical aperture of the fibre. 3
- (ii) Deduce  $\eta = \eta_0 + \eta_2 I$  for a non-linear material. Symbols have their usual meaning. 4
- (iii) What do you mean by phase matching? 1
- (iv) In a step index fibre the core has r.i. 1.46. Relative change of r.i. between core and cladding is 2%. Calculate the spread of the pulse, in space, for a length of 10 km of the fibre. 2
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