

M.Sc. 3rd Semester Examination, 2013

PHYSICS

PAPER – PHS- 302(Gr. A + B)

Full Marks : 40

Time : 2 hours

*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

GROUP – A

[Marks : 20]

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

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

(a) Indicate, which of the following molecules are microwave active molecules. Justify.

(i) CO (ii) H₂ (iii) D₂ (iv) CH₄ (v) HCl

(Turn Over)

- (b) Discuss, for which reason laser can not be obtained from a two level laser system. Give one example of three level laser.
- (c) Rotational and centrifugal distortion constants of HCl molecule are 10.593 cm^{-1} and $5.3 \times 10^{-4} \text{ cm}^{-1}$ respectively. Estimate the vibrational frequency and force constant of the molecule. Given the mass of hydrogen and chlorine atoms are $1.673 \times 10^{-27} \text{ kg}$ and $58.06 \times 10^{-27} \text{ kg}$ respectively.
- (d) What is the average period of rotation of HCl molecule if it is in the $J = 1$ state. The inter-nuclear distance of HCl is 0.1274 nm . Given the mass of hydrogen and chlorine atoms are $1.673 \times 10^{-27} \text{ kg}$ and $58.06 \times 10^{-27} \text{ kg}$ respectively.
- (e) Show the allowed transitions and the Raman spectrum arising in a linear molecule.
- (f) Write Born-Oppenheimer approximation for molecular rotational, vibrational and electronic

(3)

spectroscopy. If the above wave functions of a molecule are ψ_r , ψ_v , ψ_e and the respective energies are E_r , E_v and E_e , find the total wave function and energy of the molecule according to the principle.

2. Obtain the equation of population inversion in a three level laser system. Derive the expression for threshold pumping power required to start laser oscillation from a three level laser. Calculate the threshold power required for a Ruby laser with number of atom per cc is 1.6×10^{19} ; spontaneous lifetime is 3×10^{-3} s and operating frequency is 6.25×10^{14} Hz. Describe the method of *Q*-switching by Electro optical shuttering. 4 + 2 + 1 + 3
3. Clearly express the change in the spectrum considering the effect of interaction of rotation and vibration in a molecule. Explain how intensity of vibrational-electronic spectra varies when the upper state inter-nuclear distance is greater than the ground state. 7 + 3

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GROUP – B

[Marks : 20]

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

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

- (i) Discuss the principle of optical NOR logic operation with non-linear material.
- (ii) Give a comparative study of single mode step index and single mode graded index optical fibres.
- (iii) Describe the characteristics of a hologram.
- (iv) The refractive indices of an optical fiber are 1.46 (core) and 1.44 (clad), Calculate the aperture angle of the optical fiber.
- (v) Compare focusing by a convex lens with the self-focusing by a non-linear material.
- (vi) Discuss, why there is no antisymmetric TE type of electromagnetic wave is found in a planar waveguide.

2. What is multipath broadening in an optical fiber ? Obtain the expression of this multipath broadening of pulse. Obtain the expression of TE symmetric mode of light in a planar waveguide. 1 + 3 + 6

 3. What do you mean by second harmonic generation of laser ? What do you mean by phase matching condition ? Discuss, the method of obtaining the second harmonic light from a non-linear material with supporting figure. 1 + 2 + 7
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