PG (CBCS) ODD SEMESTER EXAMINATION, 2022

PHYSICS

3rd Semester

Course No. : PHYCC - 304D

(Non-linear Optics and Laser Spectroscopy - I)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

(Answer any five questions, taking one from each unit)

UNIT - I

1. (a) Consider a non-linear response
$X_{out} = K(X_{in} + \in X_{in}^2)$ where $\in < 1$.
If X_{in} = A cos ωt, show that the output (X_{out}) will contain a 2nd harmonic of the fundemental frequency (ω). 4

   (b) Define non-linear optical susceptibility. Show how use of contracted rotation (d_{il}) can reduce the number of independent elements in the matrix representation of $x^{(2)}_{ijk}$. 10

2. Deduce the equation for non-linear susceptibility describing second harmonic generation (SHG)

considering the classical an harmonic oscillator model is a non-centro symmetric medium. 14

UNIT - II

3. (a) Derive the non-linear equaton fore a loss less, dispersive medium. 8

   (b) Write the Manley-Rowe equations for sum frequency generation and interpret the results. 6

4. Solve the coupled wave equations for difference frequency generation and hence explain the parametric amplication process. Consider $\Delta k = 0$. 14

UNIT - III

5. (a) Discuss the tensor nature of third order susceptibility $x_{ijkl}^{(3)}$ 8

   (b) Derive the expression

   $$\bar{n}_2 = \frac{3x^{(3)}}{4n_0}$$

   where symbols have their usual meanings. 4

   (c) Distinguish between DC and optical kern effects. 2

6. Derive the optical pulse propagation equation through a non-linear, dispersive medium. 14

UNIT - IV

7. (a) What are the types of electro-optic effect? Develop a mathematical formalism to describe linear electro optic effects. 2+12=14

8. (a) Distinguish between Raman-Nath and Bragg scatterings. 4

   (b) Give a mathematical analysis of Raman Nath scattering. Show that $\theta = \frac{l\lambda}{\Omega}$,

   (symbols have their usual meanings) 8+2=10

UNIT - V

9. Deduce the density matrix equation of motion for two level system in absence of demping. Modify the equations for (a) closed and (b) open systems in presence of relaxation processes. 8+3+3=14

10. Derive the optical Bloch equations for a two-level system. 14

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