This question paper contains 2 printed pages. Your Roll Number.....

Sr. No. of questions Paper	:**8125**
Unique Paper Code	:**2223510038**
Name of the Paper	: Applied Optics
Name of the Course	: B.Sc. Prog.–Physical Sciences with Electronics_NEP: UGCF-2022
Semester	: VIII (DSE Paper)
Duration	: 2 hours Maximum
Marks	: 60 Marks

Instructions for candidates:

i. Write your Roll No. on the top immediately on receipt of this question paper.
ii. Attempt total of four questions, out of which Question 1 is compulsory.
iii. Use of a non-programmable scientific calculator is permissible.
iv. Some useful constants are given at the end.

1. Attempt any five; each questions have equal marks. (5×3=15)
   a. What is population inversion? Explain why laser action cannot occur without population inversion between atomic levels?
   b. Briefly explain spatial coherence and temporal coherence in laser.
   c. What is holography: describe the experimental setup for Gabor's on-line holographic recording. What are the limitations of Gabor's experiments?
   d. Discuss any two applications of an optical Fiber as a sensor.
   e. What does Fourier transform and how can it be performed optically?
   f. Explain holographic interferometry.

2. (a) Prove the Einstein Coefficients relation $\frac{A_{21}}{B_{21}} = \frac{8\pi\nu^3 h}{c^3}$ and $B_{21} = B_{12} = B$ (6)

   (b) Prove that (thermal equilibrium) the ratio of the number of spontaneous to stimulated emission is given by $R = \frac{A_{21}N_2}{B_{21}N_2}u(\omega) = \exp\left(\frac{\hbar\omega}{k_B T}\right) - 1.$ (4)

   (c) Write laser rate equation for two level system consisting of energy levels E_1 and E_2 with N_1 and N_2 atoms per unit volume respectively. (5)

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3. (a) Define the relative refractive index difference for an optical Fiber and show how it is related to the numerical aperture. (6)

   (b) A step index Fiber has a solid acceptance angle in air of 0.115 radian and a relative refractive index difference of 0.9%. Estimate the speed of light in Fiber core. (5)

   (c) Consider a step index Fiber with $n_1 = 1.5$, $\Delta=0.015$ and a= 40 μm operating at 850 nm with a spectra width of 50 nm. Find out whether Fiber will be single mode or multimoded. (4)

4. (a) Explain the Fourier transform property of a thin lens. (8)

   (b) The field variation on the front focal plane of a lens of length 20 cm is given as $g(x,y) = A + B\cos(6\pi x) + C\cos(12\pi y)$ where (x,y) in millimetres. Calculate the spatial frequency in the field. (7)

5. Briefly explain the following

   (a) Volume Holograms (5)

   (b) Thick Holograms (5)

   (c) Multiplex Holograms (5)

Some useful constants: Boltzmann constant 1.38×10^{-23} J/K, Universal Gas constant, R = 8.31 J/mole-K, Avogadro's number = 6.022×10^{23} per mol, 1 amu = 1.67×10^{-27} kg. The symbols U, T, P, γ stand for standard notations. One calorie=4.2 J, 1eV= 1.6×10^{-19} J, Stefan-Boltzmann constant, $\sigma = 5.67\times10^{-8}$ W/m^2-K^4, Plank constant, $h = 6.63\times10^{-34}$ J-s, Speed of light in vacuum (c) = 3×10^8 m/s, electron charge (e) = 1.60210×10^{-19} C and Rydberg constant (R_H)= 1.0967758×10^7 m^{-1}.