K25P 0942

Reg. No. : .....

Name : .....

IV Semester M.Sc. Degree (CBCSS – OBE – Regular) Examination, April 2025
(2023 Admission)
PHYSICS
MSPHY04E04 : Optics and Photonics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any 5**, **each** question carries **3** marks.

1. Explain rate equation for two level atomic system.
2. What is the role of He in He-Ne laser ?
3. What is stimulated Raman scattering ?
4. Differentiate between intramodel and intermodal dispersion.
5. Define the number state (Fock state) and explain its significance in quantum optics.
6. Briefly explain the concept of a coherent state and its relation to classical electromagnetic waves. **(5×3=15)**

SECTION – B

Answer **any 3**, **each** question carries **6** marks.

7. A multimode step-index fibre has a relative refractive index difference of 2% and a core refractive index of 1.5. The number of modes propagating at a wavelength of 1.3 μm is 1000. Calculate the diameter of the fibre core.
8. There is a 30 km long fibre. It attenuated light at a rate of 0.8 dB/km, when light with a wavelength of 1300 nm travels through it. If a 200 watt power is launched into the fibre, how much of the original light power will emerge from the other end of the fibre after travelling through its entire length ?

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9. At what temperature the rates of spontaneous and stimulated emissions become equal ? Assume $\lambda = 500$ nm.
10. Consider a beam splitter with transmittance T = 0.7 and reflectance R = 0.3. A single photon in state $|1\rangle$ is incident on one input port, while the other input port is in the vacuum state $|0\rangle$. Calculate the probabilities of detecting the photon in the two output ports.
11. A laser beam of wavelength 740 nm has coherence time 4×10^{-5} s. Deduce the order of magnitude of its coherence length and spectral half width. **(3×6=18)**

SECTION – C

Answer **any 3**, **each** question carries **9** marks.

12. With an energy level diagram, explain the principle and working of Ruby laser.
13. Explain the basis of harmonic frequency generation in crystals. Why second harmonic generation is not shown by isotropic media ?
14. Discuss the possible signal degradation in optical fibres.
15. Derive the interaction Hamiltonian for the Jaynes-Cummings Model (JCM). Explain the concept of dressed states and their significance in the JCM. Discuss an experimental realization of the JCM.
16. Discuss the classical coherence functions and their quantum counterparts. Explain the importance of higher-order coherence in understanding quantum phenomena. Illustrate these concepts with examples from experiments with single photons. **(3×9=27)**