

Reg. No. :

Name :

IV Semester M.Sc. Degree (CBCSS – OBE – Regular/Supple./Imp.)
Examination, April 2026
(2023 Admission Onwards)
PHYSICS
MSPHY04E04 : Optics and Photonics

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer any 5, each question carries 3 marks.

1. Explain the threshold condition for lasing.
2. Bring out the significance of the quality factor of a laser cavity.
3. Briefly describe the phase matching condition for second harmonic generation.
4. What is meant by the mode of an optical fiber? Explain the formation of modes in optical fibers.
5. Differentiate between step index and graded index fibers.
6. What is meant by quantum fluctuation? (5×3=15)

SECTION – B

Answer any 3, each question carries 6 marks.

7. A ruby laser contains a crystal of length 4 cm and a refractive index of 1.78. The peak emission wavelength from the device is 0.55 μm . Determine the frequency separation between the longitudinal modes.
8. Calculate the ratio of the stimulated emission rate to spontaneous emission rate for an incandescent lamp operating at a temperature of 1000 K. Assume the average operating wavelength to be 0.5 μm .

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9. The velocity of light in the core of a step-index fiber is $2.01 \times 10^8 \text{ m/s}$ and the critical angle at the core-cladding interface is 80° . Determine the numerical aperture and acceptance angle (maximum entrance angle) for the fiber in air. The velocity of light in vacuum is $2.998 \times 10^8 \text{ m/s}$.
10. An optical signal has lost 55% of its power after traversing 3.5 km through an optical fiber. What is the attenuation in dB/km of this fiber?
11. Consider the superposition of the vacuum and 10 photon number states $|\psi\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |10\rangle)$. Calculate the average photon number for this state. (3×6=18)

SECTION – C

Answer any 3, each question carries 9 marks.

12. Give a detailed description of Q-switching with a schematic representation of how a) loss, b) quality factor, c) population inversion and d) laser output power vary with time when a laser is Q-switched. Obtain expressions for the peak power output and pulse duration.
13. What are three and four level lasers? Write down the rate equations for three and four level laser systems and compare their pumping requirements.
14. What is harmonic generation? Discuss second and third harmonic generation in detail.
15. Explain in detail the causes of signal distortion in optical fibers. How does signal distortion affect the information carrying capacity of the optical fiber?
16. What are coherent states? Show that coherent states minimize the uncertainty product and exhibit equal uncertainties in each quadrature. (3×9=27)