C 2065 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION MARCH 2021

(CBCSS)

Physics

PHY 4E 13—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Syllabus Year)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 *Short questions answerable within* 7.5 *minutes.*
Answer **all** *questions, each question carries weightage* 1.

1. What are the characteristic properties of laser light ?
2. Write a note on stable and unstable resonators.
3. Briefly explain industrial applications of laser.
4. How does light propagation takes place in an optical fiber ?
5. Differentiate between step index and graded index fiber.
6. Write a short note on second harmonic generation.
7. Explain any *two* methods to achieve Q-switching.
8. Explain acceptance angle and numerical aperture. How are they related ?

(8 × 1 = 8 weightage)

Turn over

Section B

4 essay questions answerable within 30 minutes.
Answer any **two** *questions, each question carries weightage 5.*

9. Explain the theory of Q switching and mode locking in lasers.
10. Explain recording and reconstruction of holograms.
11. With an energy level diagram explain the working principle of C02 laser.
12. Explain Z scan technique for measuring nonlinear refractive index and nonlinear absorption

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each question carries weightage 3.*

13. Derive the relation between Einstein's co-efficients.
14. A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm.
15. In a Ruby Laser, the total number of Cr + 3 ions is 2.8×10^{19}. If the Laser emits radiation of wavelength 600 nm, then calculate the energy of one emitted photon and total energy available per pulse.
16. The refractive indices of core and cladding materials of a step index fibre are 1.53 and 1.445, respectively. Calculate : (i) Numerical aperture ; (ii) Acceptance angle ; and (iii) The critical angle at the core-cladding interface.
17. Consider the two-level system with $E_1 = -13.6$ eV and $E_2 = -3.4$ eV. Assume $A_{21} \approx 6 \times 10^8\ s^{-1}$. (a) What is the frequency of light emitted due to transitions from E_2 and E_1 ? (b) Assuming the emission to have only natural broadening, what is the FWHM of the emission ?
18. Calculate the gap in frequency between two longitudinal modes in a linear cavity whose optic length, L, = 250 mm.
19. The spontaneous lifetime of the sodium level leading to a D1 line (λ = 589. 1nm) is 16 ns. Find the natural line width Full width half maximum, $\Delta\lambda$?

(4 × 3 = 12 weightage)