) 101299 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2024

(CBCSS)

Physics

PHY 4E 14—LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

(2019 Admission onwards)

me : Three Hours Maximum : 30 Weightage

Section A

8 Short questions, each answerable within 7.5 minutes.

Answer **all** *questions, Each question carries weightage 1.*

1. Explain Doppler broadening mechanism in lasers
2. Discuss briefly what unstable resonators are.
3. Explain Z scan technique
4. Explain any two applications of spatial frequency filter
5. What is a fibre laser ? What are the advantages of fibre laser over other lasers ?
6. Mention the medical applications of lasers
7. Give the two requirements for lasing action in a semiconductor diode. Explain how lasing action occurs in it.
8. Compare step index and graded index optical fibre.

(8 × 1 = 8 weightage)

Section B

4 Essay questions, each answerable within 30 minutes.

Answer any **two** *questions, Each question carries weightage 5.*

9. Explain the technique of mode-locking. How it is used to generate very short optical pulses of high peak power ?
10. Explain the application of lasers in material processing and isotope separation.

Turn over

11. Derive the laser rate equations for a three level laser system and a four level laser system.

12. Explain the working principle of singly resonant oscillator.

(2 × 5 = 10 weight

Section C

7 Problem questions, each answerable within 15 minutes.

Answer any **four** *questions, Each question carries weightage 3.*

13. For a cavity with mirrors having reflectivities of 98 %, what would the minimum gain need to order for the laser to reach threshold if the amplifier length is 0.2 m. and the mirror separ is 0.4 m ? Assume no losses in the cavity other than the mirror transmission losses.

14. For a ruby laser of 6328 Å wavelength, the spontaneous emission coefficient is $10^7\ s^{-1}$. The a medium of length 20 cm. and refractive index of 1.76 is installed in a two-mirror cavity ha mirror reflectivities of 99.9 % and 98 %. Calculate the time in which energy in the cavity is red by a factor of 1/e. Also find the threshold population inversion. Given the normalised line sh function as 1.6×10^{-10}s. Assume no losses in the cavity other than the mirror transmission lo

15. Explain threshold population inversion.

16. Describe the theory of recording and reconstruction of image in a hologram.

17. Find the phase matching criteria and hence the refractive index criteria for the efficient se harmonic generation

18. A He-Ne laser operating at 632.8 nm. has an output power of 1.0 mW with a 1 mm. beam diam Power in the cavity is 99 P since the output mirror has 1% transmission. The beam diameter is 1 mm inside the laser cavity and the power is uniform over the beam cross section. The D linewidth is 1.5×10^8 Hz. What is the ratio of stimulated and spontaneous emission rates ? Wh the effective blackbody temperature of the laser beam near the output mirror in the cavity ?

9. The core diameter of a single mode optical fiber is 10 μm. the fiber is coupled to semiconductor l rated to operate at 1.3 μm. The refractive index of the core glass material is 1.55. The maxim numerical aperture is 0.995. Calculate the refractive index of the cladding. Show that all the r making an angle <5.712° with the axis of fiber will be guided through it.

(4 × 3 = 12 weight