



Reg. No. : .....

Name : .....



VI Semester B.Sc. Degree (CBCSS – Reg./Supple/Improv.)

Examination, April 2021

(2014-2018 Admissions)

CORE COURSE IN PHYSICS

6B12PHY : Photonics and Spectroscopy

Time : 3 Hours

Max. Marks : 40

Instruction : Write answers in English only.

SECTION – A

Answer all questions – Very short answer type – Each question carries

1 mark :

1. Give an example of a three-level laser.
2. What is meant by population inversion ?
3. What is the principle of optical fiber ?
4. Give one advantage of hologram over ordinary photograph. (4x1=4)

SECTION – B

Answer any seven questions – Short answer type – Each question carries

2 marks :

5. What is the difference between step index fiber and graded index fiber ?
6. Define acceptance angle. Give an expression for it.
7. Give any four applications of holography.
8. Explain the principle of working of a microwave oven.
9. Explain pulse dispersion in step index fiber.
10. What is the difference between single mode fiber and multi-mode fiber ?
11. Draw the energy level diagram of Ruby laser.



12. Derive an expression for numerical aperture.
13. What is an anharmonic oscillator ?
14. What is the basic principle of holography ?
15. Explain isotope effect in rotational spectra.
16. Molecules such as HCl and CO show rotational spectrum while  $N_2$  and  $O_2$  will not. Why ?
17. Homonuclear diatomic molecules do not show vibrational spectra. Why ?
18. Explain the P branch and R branch of a rotation vibration spectrum. (7×2=14)

## SECTION – C

Answer **any four** questions – Short essay/problem type – **Each** question carries 3 marks :

19. Calculate the numerical aperture and acceptance angle of a fiber having core refractive index = 1.5 and cladding refractive index = 1.45.
20. The energy level difference between two laser level is 0.22eV. Determine the wavelength of radiation.
21. A step index fiber has a core diameter of 200 $\mu$ m, its numerical aperture is 0.29. Calculate the number of propagating modes of an operating wavelength of 859 nm.
22. The moment of inertia of the CO molecule is  $1.46 \times 10^{-46}$  kgm<sup>2</sup>. Calculate the energy (in eV) and the angular velocity in the second lowest rotational energy level of the CO molecule ( $J = 1$ ).
23. The equilibrium vibration frequency of the iodine molecule is 215 cm<sup>-1</sup> and the anharmonicity constant  $x_e = 0.003$ . What is the intensity of the hot band  $v = 1 \rightarrow v = 2$  relative to that of the fundamental  $v = 0 \rightarrow v = 1$ , if the temperature is 300K.
24. A Ruby Laser emits light of wavelength 694.4 nm. If a laser pulse is emitted for  $1.2 \times 10^{-11}$ s and the energy releases per pulse is 0.15J.
  - i) What is the length of the pulse ?
  - ii) How many photons are there in each pulse ?



25. Explain briefly the concept of optical pumping.
26. Assuming the wavelength as 6000Å°, Find the temperature at which the ratio of rates of spontaneous and stimulated emission becomes unity.  
Given  $k_B = 1.38 \times 10^{-23}$  J/K. (4×3=12)

## SECTION – D

Answer **any two** questions – Long essay type – **Each** question carries 5 marks :

27. What is optical Resonator ? Briefly discuss the construction and working principle of He-Ne Laser.
28. What are Einstein coefficients ? Derive the relation between probabilities of spontaneous emission and stimulated emission in terms of Einstein coefficients.
29. Qualitatively describe the principle, recording and reconstruction of image using holographic method.
30. Obtain an expression for the rotational energy levels of a diatomic molecule taking it as a rigid rotor. Draw the energy level diagram of a rigid diatomic rotor.
31. What are the various energy components possessed by a molecule ? With energy level diagram explain vibrational spectrum of diatomic molecule. Discuss selection rules involved.
32. Explain the different types of line broadening mechanisms and explain the working of semiconductor lasers. (2×5=10)