## Question Bank for LASER and Fiber Optics

Lasers

1. What is LASER? Discuss its different characteristics.
2. Explain absorption, spontaneous emission and stimulated emission with suitable diagrams.
3. Write short note on stimulated emission explaining its importance for laser production.
4. State Boltzmann's distribution law and hence show that in normal conditions ground state will remain most populated.
5. Explain Einstein's A and B coefficients in relation with the theory of lasing.
6. What is meant by metastable state? What is its significance?
7. Explain population inversion, active system and pumping.
8. What is meant by pumping? Why it is necessary for laser production? Discuss different types of pumping mechanisms.
9. Explain why simple heating cannot achieve population inversion.
10. Why lasing cannot be obtained using only two energy levels?
11. Distinguish between 3-level and 4-level lasers.
12. What is an optical resonator? Explain in detail how it plays a key role in laser production.
13. Explain the construction and working of Ruby and He-Ne lasers with energy level diagrams.
14. Explain the construction and working of a carbon-dioxide laser with energy level diagram. What are the roles of Helium and Nitrogen gases?
15. Explain semiconductor laser. What are the advantages of it?
16. List the applications of laser in different fields.
17. Write a short note on holography.

Fiber optics

1. What is an optical fiber? What is the main principle involved in its working?
2. With a neat diagram explain the structure of an optical fiber.
3. Explain the following terms related to optical fiber: a) critical angle, b) acceptance cone, c) numerical aperture and d) V-number.
4. Describe the propagation of light in an optical fiber and obtain expressions for critical angle, acceptance angle and numerical aperture in terms of its core and cladding refractive indices.
5. Classify the optical fibers on the basis of refractive index profile, on the basis of modes and on the basis of materials.
6. Differentiate between the step-index and graded-index (GRIN) fiber.
7. Discuss different loss mechanisms encountered in an optical fiber.
8. What is attenuation in an optical fiber? Explain the attenuation mechanism.

9. What is meant by dispersion in an optical fiber? What are the different causes of dispersion in optical fiber? Explain in detail.
10. What are the advantages of optical fiber over conventional cables?
11. What is meant by normalized frequency or V-number for an optical fiber? How it is related to the number of modes that the fiber can support?
12. Explain the important applications of optical fiber.

## Numerical Problems on LASER

1. A ruby laser has its metastable state at 1.79 eV from which the stimulated emission produces laser light. Calculate the wave length of the light. If 1 mole of $Cr^{+3}$ ions are involved in population inversion process in a pulse, calculate the pulse energy in eV. [Given, $h = 6.625 \times 10^{-34}$ *J-s* $= 4.14 \times 10^{-15}$ *eV-s*, $c = 3 \times 10^{8}$ *m/s*]

   [Ans. 693.95 nm, $1.077 \times 10^{24}$ eV]
2. A laser having power of 75 mW, wavelength 720 nm and an aperture 5 mm is focussed with a lens of focal length of 0.1 m. Calculate the area and intensity of the image.

   [Ans. $2.074 \times 10^{-10}$ $m^2$, $3.616 \times 10^{8}$ $W/m^2$]
3. In a He-Ne laser system, the two energy levels of Ne involved in lasing action have energy values of 20.66 eV and 18.70 eV. Population inversion occurs between these two levels. What will be the wavelength of the laser beam produced? What will be the population of the metastable energy level with respect to the upper excited level at room temperature (27°C)?

   [Ans. 633.76 nm, $N_{2,Ne} = 7.89 \times 10^{32}$ $N_{3,Ne}$]
4. Find the separation between metastable and excited levels for two wavelengths of 9.6 μm and 10.6 μm emitted from a $CO_2$ laser source. Calculate the frequency and hence the energy of the light photons emitted. How many photons are required to be emitted per second to obtain a laser output power of 10 kW?

   [Ans. $4.83 \times 10^{23}$ and $5.34 \times 10^{23}$ photons per sec]
5. Calculate the wavelength of emission from GaAs semiconductor laser whose band gap energy is 1.44 ev (plank's constant is $6.625 \times 10^{-34}$ Js and charge of an electron is $1.6 \times 10^{-19}$ C.

   [Ans. 8626.3 $A^o$ ]

## Numerical Problems on Optical Fiber

1. Find out the numerical aperture and acceptance angle of an optical fibre. [Given, $n_1 = 1.55$, $n_2 = 1.50$]

2. A fibre cable has an acceptance angle of $30^0$ and a core index of refraction of 1.4. Calculate the refractive index of the cladding.

3. Calculate the refractive indices of the core and cladding material of a fibre from following data. Numerical aperture = 0.22 and fractional difference of indices = 0.122.

4. In an optical fiber, the core material has R.I 1.6 and R.I. of clad material is 1.3. What is the value of critical angle? Also calculate the value of angle of acceptance cone.

5. A step index fibre is made with a core of R.I 1.52, a diameter of 29 micrometer and a fractional difference index of 0.0007. It is operated at a wavelength of 1.3 μm. Find the V-number and the number of modes the fiber will support.

6. Optical power of 1 mW is launched into an optical fiber of length 100 m. If the power emerging from the other end is 0.3 mW, calculate the fiber attenuation.
7. What is the attenuation in dB/km, if 15% of the power fed at the launching end of a 0.5 km fiber is lost during propagation?
8. A step-index fiber has a normalized frequency V = 26.6 at 1300 nm wavelength. If the core radius is 25 μm, calculate the numerical aperture.