# Department of Applied Physics
# Applied Physics
# Question Bank
# Session – 2012-13
## UNIT – II - Lasers & Fiber Optics

**Multiple Choice Questions**

1. The population inversion necessary for laser action used in ruby laser is :

   (a) electric discharge

   (b) optical pumping

   (c) direct conversion

   (d) Inelastic atom-atom collision.

2. Out of the following, which one is a two level laser:
   (a) CO2 laser
   (b) He-Ne laser
   (c) Ruby laser
   (d) Semiconductor laser
3. Laser beam is highly coherent, so it can be used in:
   (a) interference
   (b) diffraction
   (c) polarization
   (d) scattering.
4. Which of the following is not true for LASER?
   (a) extremely intense light
   (b) perfectly monochromatic
   (c) coherent
   (d) divergent.

**Short Answer Questions**

1. What is the difference between a hologram and an ordinary photograph?
2. What are the characteristics of laser?
3. Explain induced Absorption, Spontaneous Emission and Stimulated Emission.
4. Explain population inversion.
5. Explain Meta- stable state.
6. Explain Principle of LASER.
7. What are the main differences of ordinary light and LASER?
8. What are the various pumping processes for LASER? production?
9. What are the applications of laser?
10. What is meant by step index and graded index fibre?
11. What is fibre optics?
12. What is optical computing?

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**Long Answer Questions**

1. What do you understand by coherence? Explain Temporal Coherence and special coherence. Derive the condition for spatial coherence.
2. Give reason for the two level system not preferring population inversions and hence no stimulated emission.
3. What are the main components of a laser?

OR

4. Explain the various processes happening in the active medium resulting in the production of laser?
5. What are the basic properties/characteristics of laser?
6. Which atoms are used as active centre in Ruby laser and give their Percentage in active medium.
7. Explain the brief the characteristics of a laser beam.
8. What are laser characteristics? Describe principle and working of He-Ne laser. Why a narrow discharge tube is used in He-Ne laser?

**OR**

Explain construction and working of He-Ne laser with neat diagrams. Why is it necessary to use narrow tubes in this laser?

**OR**

How does laser differ from ordinary light? Explain construction and working of He-Ne laser with neat diagrams. Why is it necessary to use narrow tubes in this laser?

9. Explain the semiconductor laser
10. What is a hologram? How does it differ from an ordinary photograph? Describe it.

**OR**

11. What is a hologram? How does it differ from an ordinary photograph? Describe in short how a hologram is generated and viewed?

12. What is the structure of an optical fibre? Explain the principle of propagation of light within a fibre and give expression for acceptance angle.
13. What is meant by acceptance angle for an optical fibre? Show how it is related to numerical aperture.
14. Explain the principle of propagation of light in an optical fibre. How are optical fibre classified? Describe their characteristic features.
15. What is meant by step index and graded index fibre?
16. What are the advantages of optical fibre communication system over the conventional ones? What do you understand by attenuation and V-Number in optical fibres?
17. An optical computer is a device that uses the photons of visible light or infrared (IR) beams, rather that electric current, to perform digital computations. This may perform operations significantly faster than a conventional electronic computer.
18. Describe with a neat sketch, the principle and working of a He- Ne Laser.
19. Give principle of propagation of light through optical fiber. Derive an expression for acceptance angle, also define acceptance cone.
20. Give at least six advantages of Fiber optics communication system over conventional ones. Explain the mode of propagation in stepped index multimode Fiber. Also explain modal dispersion.

**Numerical Problem**

1. In a Ruby laser total number of $Cr^{3+}$ ions is $2.8 \times 10^{19}$. If the laser emits radiation of wavelength 7000Å, then calculate energy of emitted photon and total energy available per laser pulse.
2. A glass clad fiber is made with core glass of refractive index 1.5 and the cladding is doped to give a fractional index difference of 0.0005.
3. Find (i) the cladding index (ii) the critical internal reflection angle (iii) the external critical acceptance angle (iv) the numerical aperture.
4. Find the ratio of populations of the two states in a He-Ne laser that produces light of wavelength 620 nm at 27°C
5. Imagine that we chop a continuous laser beam assumed to be perfectly monochromatic $\lambda_0$=623.8nm in to 0.1 ns pulses using some sort of shutter. Compute the resultant line width D, band width and coherence length.
6. A laser beam can be focused on an area equal to the square of its wavelength ($\lambda^2$) For a He-Ne laser $\lambda$= 6328Å If the laser radiates energy at the rate of 1mW find out the intensity of focused beam.
7. Calculate the coherence length for CO2 laser whose line width is $1 \times 10^{-5}$nm of 1R emission wavelength of 10.6μm

8. A laser beam has a power of 50mW. It has an aperture of $5*10^{-3}$m and wavelength 7000Å. A beam is focused with a lens of focal length 0.2. Calculate the areal spread and intensity of the image.
9. A certain ruby laser emits 1J pulses of light whose wave length is 6940Å. What is the minimum number of $Cr^{3+}$ ions in the ruby?
10. Find the intensity of a laser beam of 10mW power and having a diameter of 1.3mm. Assume the intensity to be uniform across the beam.
11. Determine the numerical aperture of a step index fibre when the core refractive index $n_1$= 1.5 and the cladding refractive index n2= 1.48 Find the maximum angle of entrance of light if the fibre is placed in air.
12. Numerical aperture of an optical fibre is 0.5 and core refractive index is 1.5. Find the refractive index of cladding and acceptance angle.
13. An optical fibre has a numerical aperture (NA) of 0.2 and a cladding refractive index of 1.59 Determine the acceptance angle for the fibre in water which has a refractive index of 1.33.
14. A single mode fibre is made with a core diameter of 10μm light. Its core glass has a refractive index of 1.55 calculate: (i) Maximum value required for the normalized index difference. (ii) refractive index for cladding glass (iii) value of acceptance angle (Given V-number = 2.405)
15. A step index fibre is made with a core of index 1.52, a diameter of 29μm and a fractional index difference of 0.0007. It is operated at a wavelength of 1.3 μm. Find V-number.
16. An optical power of 1 MW is launched into an optical fibre of length 100m. If the power emerging from the other end is 0.3MW, calculate the fibre attenuation?
17. An optical fibre is made of glass with a refractive index of 1.55 and is clad with another glass with a refractive index of 1.51. Launching takes place from air (1) what numerical aperture does the fibre have? (2) What is the acceptance angle?
18. An optical signal has lost 75% of its power after traversing 500m of fibre. What is the loss in db/km of this fibre?
19. A certain optical fibre has an attenuation of 3.5db/km at 850nm. If 0.5 mW of optical power is initially launched into the fibre, what is the power level in μW after 4 km?