UNIT - III
OPTICS AND LASERS
Part-A

1. **Distinguish between ordinary light and Laser.**

LASER	ORDINARY LIGHT
1.Light emitted is highly coherent	Not Coherent
2.Light emitted is highly directional	Light emitted in all directions
3.Highly monochromatic	Consist of many wavelengths
4.Highly intense and bright	Less intense and less bright

2. **Distinguish between spontaneous and stimulated emission.**

SPONTANEOUS EMISSION	STIMULATED EMISSION
1.Emission of light is not triggered by external influence	Emission of light is triggered by external influence
2.Emission takes place in random direction	Emission takes place in Particular direction
3.Emission cannot be controlled	can be controlled
4.Photons are not in Phase	Photons are in phase

3. **What are Einstein's A and B co-efficient?**

It accounts for spontaneous and stimulated emission /absorption probabilities of light by a system of particles. It also explains the importance of metastable states.

4. **Write down the characteristics of laser.**

(i) Highly coherent, (ii) Highly intense (iii) Monochromatic (iv) highly directional

5. **What is population inversion?**

Population inversion is a state in which the number of atoms in higher energy level is more than that in lower energy state. It is an essential condition for laser action.

6. Define meta-stable state.

Meta stable state is an energy level in which the excited atoms/molecules can remain stable for a little longer time (order of milliseconds) than the time spent other kinds of excited energy state (order of nanoseconds). i.e., The atoms/molecules spend more time before getting de-excited to the ground state.

7. How will you classify optical fibres based on the material? (Jan 2018)

It is classified into two types,

(i) Glass fibres&

(ii) Plastic fibres

8. Write down the methods used for pumping action.

(i) Optical pumping,

(ii) Electrical discharge,

(iii) Direct conversion,

(iv) Inelastic collision between atoms

9. What is the role of nitrogen and Helium in CO_2 laser.

In CO_2 laser the nitrogen helps to increase the population of atoms in the upper level of CO_2 while helium helps to depopulate the atoms in the lower level of CO_2 and to cool the discharge tube.

10. What are the three important component of laser device?

(i) Active medium

(ii) Pumping source

(iii) Optical resonator

11. What is optical resonator?

It is a pair of mirrors with active material in between them. One of the resonant cavities is made partially reflecting to serve as an output element passing the light out of the resonator the other mirror is highly reflecting one.

12. **What is meant by active material or active medium in laser?**

A material in which population inversion can be active for laser action is known as active material.

13. List out the conditions to be satisfied for total internal reflection?

(i) Light should travel from denser medium to rarer medium.

(ii) The angel of incidence at the interface should be greater than the critical angle.

(iii) The refractive index of denser medium should be greater than the refractive index of rarer medium.

14. List out the conditions for interference of light.

(i) There must be two sources, which are coherent in nature.

(ii) The sources should have constant phase difference (or) zero phase difference.

(iii) The sources should be closer to each other.

(iv) The distance between the sources and the screen must be larger.

(v) For constructive interference, the path difference = $n\lambda$

(vi) For destructive interference, the path difference = $(2n+1)\,\lambda/2$

15. List out the Industrial applications of laser.

Laser welding, Laser cutting, Laser Drilling, Surface alloying, Laser soldering

16. List out the conditions to be satisfied for total internal reflection?

(i) Light should travel from denser medium to rarer medium.

(ii) The angel of incidence at the interface should be greater than the critical angle.

(iii) The refractive index of denser medium should be greater than the refractive index of rarer medium.

Numerical

1. Calculate the wavelength of light emission from GaAs whose band gap is 1.44eV.
2. An atom is stimulated from the state of energy of $1x\ 10^{-34}$J to an excited level of $7.625X10^{-34}$J. What is the frequency of the photon emitted?
3. Compute the numerical aperture and acceptance angle of an optical fiber from the following data $n_1=1.55$ $n_2=1.5$ $n_o=1$.
4. A fiber cable has an acceptance angle 30^o and a core index of refraction of 1.4. Calculate the refractive index of the cladding.
5. Calculate the numerical aperture and the acceptance angle of an optical fibre from the following data. (Refractive index of core is1.55, Refractive index of cladding is1.50)
6. A step-index fibre has a numerical aperture of 0.26.Core refractive index of 1.5 and a core diameter of 100μm.calculate the refractive index of the cladding.(Ans:1.4773)

7. Calculate the numerical aperture, acceptance angle, and the critical angle of a fibre having core refractive index=1.50 and the cladding refractive index=1.45 .
8. A wedge shaped air film having angle of 0.1^{o} is illuminated by monochromatic light. Fringes are observed vertically through a microscope. The distance between ten consecutive dark fringes is 1.2cm. Find the wavelength of the monochromatic light.

Part-B (16 marks)

1. With suitable diagram explain how laser action is achieved in homojunction semiconductor laser.
2. Explain the modes of vibration modes of CO_2 molecule. Describe construction and working of CO_2 laser with energy level diagram. List out its characteristics, advantages, and applications.
3. Explain with theory, air wedge method of determining the radius of a thin wire.

Part-B (8 marks)

1. Derive an expression for Numerical aperture and acceptance angle in optical fibres.
2. Classify the fibers based on refractive index profile and number of modes.