# Engineering physics – I

## 2Mark questions with Answers

## UNIT – II

### WAVES AND OPTICS

### Lasers

**1. What is laser?**

- LASER Stands for Light Amplification by Stimulated Emission of Radiation.
- Laser is a device which emits a powerful, monochromatic, collimated beam of light. The emitted light waves from laser source are coherent in nature.

**2. What is stimulated emission?**

The process of induced emissions of photons caused by the incident photons is called stimulated emission. This process is a key factor for the operation of a laser.

**3. What are the conditions necessary for stimulated emission of radiation?**

(i) The atoms must be in the excited state.
(ii) The photon of light radiation must strike the atoms in the excited state.

**4. Mention applications of laser in communication.**

- It is used in communications between satellites and rockets and between planets i.e., inter planetary communications.
- Since laser light is not absorbed by water, it is used for underwater communication between sub-marines.
- It is used as light source for optical fibre communication.

**5. Write the differences between spontaneous emission and stimulated emission**

| | Spontaneous Emission | Stimulated Emission |
|---|---|---|
| 1 | Emission of light radiation is not triggered by external influence | Induced emissions of light radiations caused by incident photons. |
| 2 | Emitted photon travels in random direction. | Emitted photon travels in particular direction. |
| 3 | Emitted photons cannot be controlled. | Emitted photons can be controlled. |
| 4 | This process is a key factor for ordinary light | This process is a key factor for laser operation. |

**6. What is meant by population inversion and how is it achieved?**

The establishment of a situation in which the number of atoms in higher energy level is more than that in lower energy level is called population inversion. It is an essential requirement for producing a laser beam. It is achieved by pumping action.

**7. What is pumping action?**

The process of creating a population inversion in the atomic states is known as pumping action. It is essential requirements for producing a laser beam.

**8. What are the methods commonly used for pumping action?**

(i) Optical pumping (excitation by photons)
(ii) Electrical discharge method (excitation by electrons)
(iii) Direct Conversion
(iv) Inelastic collision between atoms

**9. What is Optical pumping?**

When the atoms exposed to light radiations (of energy $hv$), atoms in the lower energy state absorb these light radiations and go to excited state. This method of pumping is called optical pumping.

**10. What are the three important components of any laser device?**

(i) Active medium
(ii) Pumping source
(iii) Optical resonator

**11. What are differences between homojunction and heterojunction laser?**

| S. No | Homojunction laser | Heterojunction laser |
|---|---|---|
| 1 | Homojunction laser is made from a single crystalline material. | Heterojunction laser is made from different crystalline materials. |
| 2 | Power output is low | Power output is high |
| 3 | Pulsed output | Continuous output |
| 4 | Cost is less | Cost is more |
| 5 | Life time is less | Life time is more |
| 6 | Examples:<br>(i) GaAs<br>(ii) InP | Examples:<br>(i) GaAs / GaAlAs<br>(ii) InP / InAlP |

**12. Mention the medical applications of laser.**

(a) Treatment of detached retinas.
(b) Performing micro-surgery and bloodless operation.
(c) Treatment of human and animal cancer and skin tumours.

**13. What are the characteristics of laser?**

(i) Laser light is highly coherent
(ii) It is highly powerful and intense.
(iii) It is directional and monochromatic.
(iv) It is capable of travelling over long distance without any energy loss.
(v) It is extremely bright.
(vi) Laser beam is not easily absorbed by the water.

**14. Compare the characteristics of laser with ordinary light.**

| Sl. No | Ordinary light | Laser Light |
|---|---|---|
| 1 | Light emitted is not monochromatic. | Light emitted is highly monochromatic. |
| 2 | Light emitted does not have high degree of coherence. | Light emitted has high degree of coherence. |
| 3 | Emitted light spreads in all directions. | Emitted light spreads only in one direction |
| 4 | Light is less intense and bright. | Laser light is more intense and brighter. |

**15. What are the types of lasers? With examples.**

| Sl. No | Type of Laser | Examples |
|---|---|---|
| 1 | Solid state laser | Ruby, Nd: lasers |
| 2 | Gas laser | He – Ne, $Co_2$, Argon lasers |
| 3 | Liquid laser | SeO$Cl_2$, Europium chelate lasers |
| 4 | Dye laser | Rhodamine 6G, Coumarin dye lasers |
| 5 | Semiconductor laser | GaAs, GaAsP, GaAlAs, InP lasers |

**16. What are the drawbacks of homojunction laser diodes?**

- The output beam has large divergence.
- Coherence and stability are poor.
- Optical confinement is very poor.

## Fiber optics

**1. Define acceptance angle.**

The maximum angle at which a ray of light can enter through one end of the fiber and still be total internally reflected is called acceptance angle of the fiber.

**2. Define numerical aperture of a fiber.**

It is the light collecting efficiency of the fiber. It is a measure of the amount of light rays that can be accepted by the fiber. It is equal to the sine of the acceptance angle.

i.e., NA = $\sin\theta_0 = \sqrt{n_1^2 - n_2^2}$

where $n_1$ and $n_2$ are the refractive indice of core and cladding.

**3. Mention types of optical fibers based on the refractive index profile.**

Based on refractive index profile, the fibres are classified into

(a) Step-index fiber

(b) Graded-index fiber

**4. What are the differences between single mode fiber and multi-mode fiber?**

| Sl. No | Single mode fiber | Multimode fiber |
|---|---|---|
| 1 | In single mode fiber only one mode can propagate through the fiber. | Multimode fiber allows a large number of paths or modes for the light rays travelling through it. |
| 2 | It has smaller core diameter and the difference between the refractive index of core and cladding is very small. | It has larger core diameter and refractive index difference is larger than the single mode fiber. |
| 3 | No dispersion i.e., degradation of signal during propagation in fiber. | There is signal degradation due to multimode dispersion. |
| 4 | Fabrication is difficult and costly. | Fabrication is less difficult and not costly. |

**5. What are the differences between step index and graded index fiber?**

| Sl. No | Step index fiber | Graded index fiber |
|---|---|---|
| 1 | The refractive index of the core is uniform throughout and undergoes an abrupt (or) step change at the cladding boundary. | The refractive index of the core is made to vary gradually such that the maximum refractive index is present at the centre of the core. |
| 2 | The diameter of the core is about 10$\mu m$ in the case of single mode fiber and 50 – 200 $\mu m$ in the case of multimode fiber. | The diameter of the core is about 50 $\mu m$ |
| 3 | Attenuation is more for multimode step index fibers but it is very less for single mode step index fiber. | Attenuation is less |
| 4 | Numerical aperture is more for multimode step index fibers but it is very less for single mode step fiber. | Numerical aperture is less. |

**6. What is meant by attenuation?**

- Attenuation in fiber means 'loss of optical power' suffered by the optical signal in the fiber itself.
- It is defined as the logarithmic value of ratio of the optical power output ($P_{out}$) to the power input ($P_{in}$) per kilometre length of the fiber.

$$\text{Attenuation} \propto = \frac{-10}{L} log_{10}\left(\frac{P_{out}}{P_{in}}\right) dB/km$$

**7. What are basic attenuation mechanisms?**

(i) Absorption loss
(ii) Scattering loss and
(iii) Radiative loss

**8. Mention the types of sensors used in the fiber optics?**

There are two types of sensors used
(a) Intrinsic sensors – Here, fiber itself acts as a sensing element.
(b) Extrinsic sensors – Separate sensing system collects the light from the fiber. Fiber acts only a guiding medium.

**9. What are the essential components of optical sensors?**

(i) Light source
(ii) Light detector
(iii) Optical fiber

**10. Give the four applications of fiber optic sensors.**

- It is used as a liquid level indicator based on the principle of change in refractive index of the medium.
- Optical displacement sensors are used to find the position and displacement of the target.
- Temperature sensors are used to measure the temperature accurately.
- Laser Doppler Velocimeter (LDV) is used to measure several physical quantities such as velocity, fluid surface velocity.
- The pressure can be accurately measured using photo elastic pressure sensors.

**11. How are fibers used as a sensors?**

- The fiber optic sensors are used to detect changes in frequency, intensity, temperature, current, polarization of light waves etc.
- A fiber optic sensor modulates the light passing through it, when it is exposed to change in environment.

**12. Why are optical fibers called as wave guides?**

A wave guide is a tubular structure through which some sort of energy could be guided in the form of waves. Since light waves can be guided through a fiber, it is called wave guide.

**13. What is the basic principle of fiber sensor?**

A fiber optic sensor in general consists of a light source, fiber and a photo detector. The fiber may change the light transmission characteristics in accordance with physical parameter to be sensed.

In some sensors the fiber just acts as a wave guide and a separate sensing element used for physical parameter to be measured.

**14. What is optical fiber communication system?**

It is a communication system in which information is carried by the light through the optical fiber.

**15. Give the applications of the fiber optical system.**

- Due to large band width, the system is capable of handling a large number of channels. Thus, it finds wide applications in communications.
- It is widely used in defence services since high privacy is maintained.
- It is used for signalling purposes.
- Fiber optics is also used in cable television, space vehicles, ships and submarine cable.

**16. Mention the components involved in fiber optical communication system.**

(a) Light source
(b) Optical fiber
(c) Photo detector

**17. What are the advantages of the fiber optical communication system over the conventional system?**

- Optical fibers are light in weight and small in size.
- There is no possibility of internal noise and cross talk generation.
- No hazards of short circuits as in metal wires.
- Immunity to adverse temperature and moisture.
- Lower cost.

## Waves & Oscillation

**1. Define damped oscillation.**

Most of the oscillations in air or in any medium are damped. When an oscillation occurs, some kind of damping force may arise due to friction of air resistance offered by the medium.

So, a part of the energy is dissipated in overcoming the resistive force.

Consequently, the amplitude of oscillations decrease with time and finally becomes zero. Such oscillations are called damped oscillations.

2. **What is forced oscillation?**

   When a vibrating body is maintained in the state of oscillations by a periodic force of frequency other than its natural frequency of the body, the oscillations are called forced oscillations.

3. **Define Progressive wave**.

   A progressive wave is defined as the vibratory motion of a body which is transmitted continuously in the same direction from one particle to the successive of the medium and travel forward through the medium due to its elastic property.

4. **Define plane progressive wave.**

   Progressive wave originating from a point source and propagating through an isotropic medium travel with equal velocity in all directions.

   At any instant, the wave front will be spherical in nature. If the sphere of very large radius is considered, the spherical wave will approximate to a surface and the waves are called plane progressive waves.

5. **Define frequency.**

   The number of oscillations completed by particle in one second is called its frequency. It is denoted by n

   Frequency $n = \frac{1}{Priod\ (T)}$

6. **What are the types of oscillations?**
   1. Free oscillations
   2. Damped oscillations
   3. Forced oscillations

7. **What are the types of wave motion?**
   1. Longitudinal wave motion
   2. Transverse wave motion