Q1. Classify lasers on the basis of energy levels? Arrange them on the basis of efficiency and quality.

On the basis of energy levels, lasers are divided into 3 types.

1. 2 levels: In this, we pump electrons from ground to the laser level, which stimulates them to decay back to ground.
2. 3 levels: In this, we pump electrons to an excited level, which non-radiatively decays to the laser level, which stimulates them to decay back to the ground.
3. 4 levels: you pump to an unstable level, which decays to the laser level, which goes to another unstable level, which goes to ground.

Efficiency (η) = $Out\,put\ energy\ per\ laser\ emission\ input\ energy\,per\ excitation$ = $E3{-}E2\ E4{-}E1$
Quantum efficiency is maximum if E4 & E3 are closer; E2&E1 are closer.

So, this shows that the order of laser on the basis of efficiency and quality is η2> η3> η4.

Q2. If a laser has two states 400K and 600K and light is emitted at 6000 $X10^{-10}$ m then find the relative population of two states?

Solution in copy

Q5. What are the Einstein coefficients? Find relation between Einstein Coefficients?

Einstein coefficients are mathematical quantities which are a measure of the probability of absorption or emission of light by an atom or molecule. The Einstein A coefficients are related to the rate of spontaneous emission of light, and the Einstein B coefficients are related to the absorption and stimulated emission of light.

Q6. What do you mean by conservative field and solenoidal field. What is the nature of the field $x^2i+y^2j+z^2k$.

SOLENOIDAL FIELD: If the divergence of the vector field vanishes everywhere, then it is called a solenoidal field.

CONSERVATIVE FIELD: If the curl of the vector field vanishes everywhere, then it is called a conservative field.

Bhumika pic

Q7. What are Faraday's law of electromagnetic induction? Deduce differential form of Maxwell third equation.

Faraday’s law of electromagnetic induction, also known as Faraday’s law, is the basic law of electromagnetism which helps us to predict how a magnetic field would interact with an electric circuit to produce an electromotive force (EMF). This phenomenon is known as electromagnetic induction. Faraday’s Laws of Electromagnetic Induction consist of two laws.

Faraday’s First Law of Electromagnetic Induction

Whenever a conductor is placed in a varying magnetic field, an electromotive force is induced. If the conductor circuit is closed, a current is induced, which is called induced current.

Faraday’s Second Law of Electromagnetic Induction

Faraday’s second law of electromagnetic induction states that

The induced emf in a coil is equal to the rate of change of flux linkage.

Let us consider the Faraday’s law for induction, which relates the induced electric field to changing magnetic flux;

$$\oint \vec{E} \cdot \vec{dl} = -\frac{\partial \phi_B}{\partial t} \qquad \text{But} \qquad \phi_B = \oiint \vec{B} \cdot \vec{dS}$$

then RHS can be written as

$$\oint \vec{E} \cdot \vec{dl} = -\frac{\partial}{\partial t} \oiint \vec{B} \cdot \vec{dS}$$

Upon re-arranging

$$\oint \vec{E} \cdot \vec{dl} = -\oiint \frac{\partial \vec{B}}{\partial t} \cdot \vec{ds}$$

Apply Stoke’s theorem to the LHS

$$\oiint (\vec{\nabla} \times \vec{E}) \cdot \vec{ds} = -\oiint \frac{\partial \vec{B}}{\partial t} \cdot \vec{ds}$$

Q8 Write Maxwell Equations in integral form along with their physical significance?

Physical significance of maxwell's Ist equation

According to this total electric flux through any closed surface is 0 1 ⍰ times the total charge enclosed by the closed surfaces, representing Gauss's law of electrostatics, As this does not depend on time, it is a steady state equation. Here for positive ⍰, divergence of electric field is positive and for negative ⍰ divergence is negative. It indicates that ⍰ is scalar quantity.

Physical significance of 2nd equation

It represents Gauss law of magnetostatic as $\nabla . \vec{B} = 0$ resulting that isolated magnetic poles or magnetic monopoles cannot exist as they appear only in pairs and there is no source or sink for magnetic lines of forces. It is also independent of time i.e. steady state equation.

Physical significance of 3rd equation

It shows that with time varying magnetic flux, electric field is produced in accordance with Faraday is law of electromagnetic induction. This is a time dependent equation.

Physical significance of 4th equation

This is a time dependent equation which represents the modified differential form of Ampere's circital law according to which magnetic field is produced due to combined effect of conduction current density and displacement current density.

Q9 Differentiate between step index and graded index fibre. How material dispersion is different from wave guide dispersion?

Step index fiber :

- In this fiber data rate is very slow.
- The ray path of light propagation is looked like Zig Zag manner.
- Step index fiber of two types of fiber known as mono-mode fiber and multimode fiber.
- Coupling efficiency with fiber is very high.
- In step-index fiber the diameter of the core is about 50 -200 micrometers in the case of multimode fiber while In 10 micrometers in the case of single-mode fiber.
- Attenuation is too much more.
- The refractive index of the core is high.
- The bandwidth is low.
- It is mostly used in the application of local network communication.

Graded index fiber :

- Graded index fiber data rate is very high.
- The path of light is helical in manner.
- Graded index fiber is of only one type that are called as multimode fiber.
- Coupling efficiency is very low.
- While graded-index fiber the diameter of the core is about 50 micrometer in the case of uses multimode fiber.
- Attenuation is less.
- The Refractive index is non-uniform.
- The bandwidth is high.
- It is most commonly used in local and wide area networks.

And pms

Recording 7/3/22

Q10 How communication via optical fibre is better than by using conventional copper or co-axial cables?

1. Greater Bandwidth

Copper cables were originally designed for voice transmission and have a limited bandwidth. Fiber optic cables provide more bandwidth for carrying more data than copper cables of the same diameter. Within the fiber cable family, **singlemode fiber** delivers up to twice the throughput of **multimode fiber**.

2. Faster Speeds

Fiber optic cables have a core that carries light to transmit data. This allows fiber optic cables to carry signals at speeds that are only about 31 percent slower than the speed of light—faster than Cat5 or Cat6 copper cables. There is also less signal degradation with fiber cables.

3. Longer Distances

Fiber optic cables can carry signals much farther than the typical 328-foot limitation for copper cables. For example, some 10 Gbps singlemode fiber cables can carry signals almost 25 miles. The actual distance depends on the type of cable, the wavelength and the network.

4. Better Reliability

Fiber is immune to temperature changes, severe weather and moisture, all of which can hamper the connectivity of copper cable. Plus, fiber does not carry electric current, so it's not bothered by electromagnetic interference (EMI) that can interrupt data transmission. It also does not present a fire hazard like old or worn copper cables can.

5. Thinner and Sturdier

Compared to copper cables, fiber optic cables are thinner and lighter in weight. Fiber can withstand more pull pressure than copper and is less prone to damage and breakage.

6. More Flexibility for the Future

Media converters make it possible to incorporate fiber into existing networks. The converters extend UTP Ethernet connections over fiber optic cable. **Modular patch panel solutions** integrate equipment with 10 Gb, 40 Gb and 100/120 Gb speeds to meet current needs and provide flexibility for future needs. The panels in these solutions accommodate a variety of cassettes for different types of fiber patch cables.

7. Lower Total Cost of Ownership

Although some fiber optic cables may have a higher initial cost than copper, the durability and reliability of fiber can make the total cost of ownership (TCO) lower. And, costs continue to decrease for fiber optic cables and related components as technology advances.