#Dev Kunwar Singh

B.tech (First Semester) (2023-24)

ENGINEERING PHYSICS

Section - A

(Short Answer type)

1- Explain the conclusions of Michelson-Morley Experiment.

Ans → • Michelson was Aimed to determine the relative velocity of earth with respect to stationary medium ether.

• It was supposed that whole earth is filled with some hypothetical medium called ether.

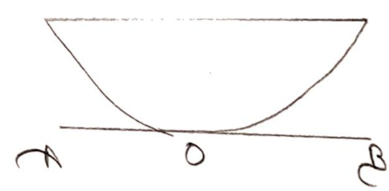
• They tried to find out the relative motion by measuring the speed of light in different direction on earth surface.

• Michelson Morley were surprised to see that no shift in fringe was observed when interferometer was rotated through 90° They repeated it at different places, time different height but they found no shift. They could not detect earth relative motion.

2- Explain the centre of Newton's ring appears dark in reflected light.

Ans → from equation of destructive interference

$2\mu t = n\lambda$



The value of 't' thickness at point of contact is 0.

$\boxed{2\mu t = n\lambda}$ where $n = 1, 2, 3$

∴ from this it is clear that newton centre ring appear dark in reflected light.

3.- Difference between Fresnel and Fraunhofer diffractions.

Ans- Fresnel's Diffraction- In fresnel's class of diffraction the Source of diffraction of light or Screen on which diffraction pattern is observed are both at finite distances from the obstacle or aperature.

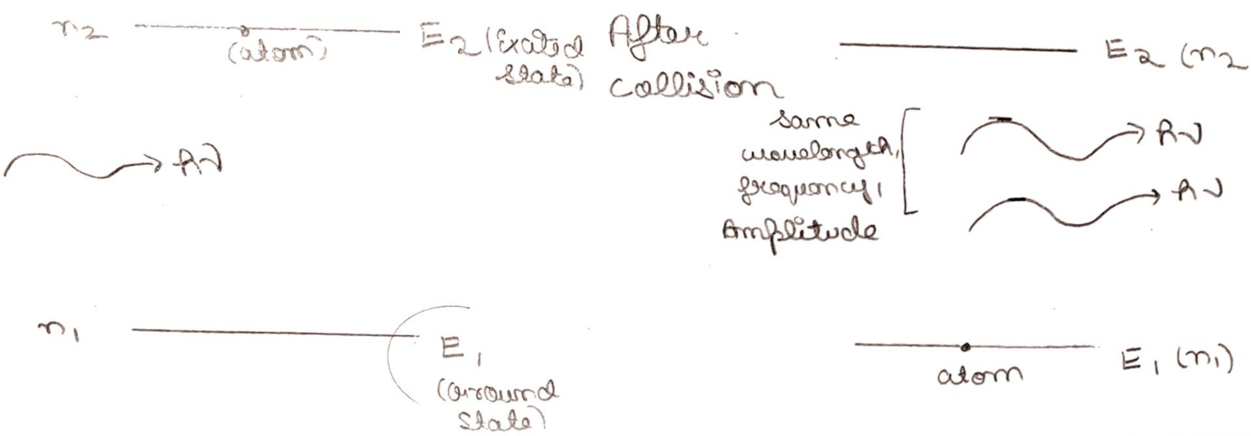
Fraunhofer Diffraction- In fraunhofer class of diffraction the Source of light or Screen are effectively at infinite distances from the obstacle or aperature showing diffraction.

4- Explain in brief the principle of laser.

Ans → • The word LASER is "Light Amplification by Stimulated emission of Radiation"

• Its working principle based on the process of Stimulated Emission.

• when an atom in Excited state E_2 and a photon of Energy $h\nu$ incident on it and induces the atoms to come down to lower Energy level E_1 by omitting a New photon. For every one incident photon there will be another photon release of same frequency, same phases travelling in same direction. Such transition is called Stimulated Emission.



5- Define numerical Aperture.

Ans- • It is a number which define the light Acceptance or gathering capacity of a fibre.

• In simple term, there is a maximum angle made by the fiber so that it is propogate in the core by the several internal reflection.

• The sin of this maximum angle (acceptance Angle) is a Numerical Aperture (NA)

• $NA = \sin\alpha = \frac{1}{\mu_0}\sqrt{\mu_1^2 - \mu_2^2}$

$\Delta = \frac{(NA)^2}{2\mu_1^2}$ or $(NA)^2 = 2\mu_1^2\Delta$

$\therefore N = \mu_1\sqrt{2\Delta}$

6- Discuss different types of hologram

Ans- (i) Transmission hologram - It is viewable with laser light. This is made with both object and reference waves approaching the film.

(ii) Multiple channel hologram - The two or more images are visible from different angles. The different type of multiple channel.

(iii) multiplex - A large number of flat pictures of a subject viewed from different angles are combined into single 3D image of object.

(iv) Rainbow hologram - The same image appears in different colours when viewed from different angles.

(v) Simple ones - with 2,3 or a few images each viewed from different angles.

7- Explain at least two appliuations of holography in medical field.

Ans- (i) Holography can help radiologists identify injuries and fractures in soft and hard tissue. Holograms can also store patient medical records digitally.

(ii) Orthopaedics

Holograms can be used to analyse patient conditions, predict causes, and plan surgical procedures.

(iii) Research

Holograms can be used do study effects of drugs on a patient, and to research chronic kidney disease.

8- Explain the significance of mass energy-relation.

Ans- • Mass Energy Equivalence establishes the the relationship between mass and Energy. Mass Energy Equivalence was one of the most important discoveries that took place at the end of 20th century.

$\therefore E = mc^2$

• The formula says that the rest mass of a small amount resembles a large amount of Energy even though it's independent in the making of the matter.

9- Explain Scattering loss in fibre.

Ans- The glasses are known as disordered structure with localization for group of atoms. Such group is a structure cause scattering of propogated light signal rather being influenced of it However a slight influence of propogated light on glass material is always present hence these losses are known as Scattering losses (not like reflection losses).

10- Define specific rotation.

Ans- Specific Rotation is the property of a substance by virtue of which it can show the phenomenon of optical rotation. In other words, specific rotatory power of a substance for a given wavelength of Light at a particular temperature is defined as optical rotation.

Section-B

(Long Answer type Questions)

1- Explain the fundamental postulates of special theory of relativity and deduce them from the Lorentz transformations.

Ans → As a result of failure of Michelson Morley Experiment Einstein in 1905 advanced his special theory of relativity.

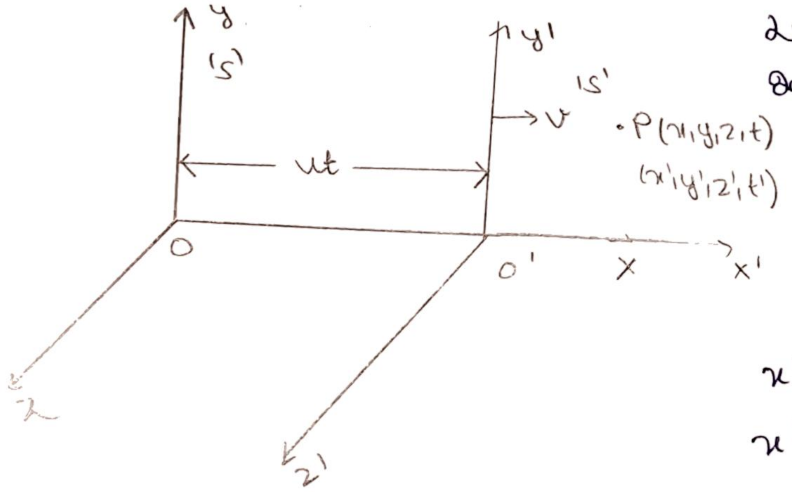
(i) Principle of Equivalence

The laws of physics are same in all inertial frame of reference.

(ii) Principle of Constancy speed of light.

Speed of light is constant in all inertial frame of reference.

Lorentz Transformation Equations



Let S and S' are two inertial frame of reference. The frame S' is moving with constant velocity 'v' along Positive 'x' axis.

$$x' \propto (x - vt)$$

$$x' = \beta(x - vt) \quad -(1)$$

The frame S is moving with '-v'

$$x \propto (x' + vt)$$

$$x = \beta(x' + vt) \quad -(2)$$

Put the value of x' from eq ① in eq ②

$x = \beta(\beta(x - ut) + ut'))$

$x = \beta(\beta x - \beta ut + ut'))$

$x = \beta^2(x - ut) + \beta ut' \Leftrightarrow \frac{x}{\beta} = \beta(x - ut) + ut'$

$\Leftrightarrow ut' = \frac{x}{\beta} - \beta x + \beta ut$

$\Leftrightarrow$

$$\frac{\beta}{\beta} \times \frac{x}{v\beta} - \frac{\beta x}{v} + \frac{\beta ut}{v} = t' \quad \text{(divide by v)}$$

$$t' = \frac{\beta x}{v\beta^2} - \frac{\beta x}{v} + \beta t = t' \Leftrightarrow t' = \beta t - \frac{\beta x}{v}\left(1 - \frac{1}{\beta^2}\right) - (3)$$

A/Q Einstein 2nd postulate

speed of light remains same in all inertial frame of references.

$x = ct - (4)$

$x' = ct' - (5)$

Put (4) and (5) in eq 1 & 2

$$ct' = \beta(ct - ut) - (6)$$

$$ct = \beta(ct' + ut) - (7)$$

multiply 6 × 7

$$c^2 \cancel{tt'} = \beta^2 \cancel{tt'}(c^2 - v^2)$$

$$\boxed{\beta = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}} - (8)$$

Put eq (8) in eq (3)

$$t' = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \times \frac{x}{v}\left(1- \left(1-\frac{v^2}{c^2}\right)\right)$$

$$t' = \beta t - \frac{\beta x}{v}\left(\frac{v^2}{c^2}\right) \Leftrightarrow \boxed{t' = \beta\left(t - \frac{xv}{c^2}\right)}$$

$$\boxed{t' = \frac{t - \frac{xv}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}}$$

Put the value of β in eq 1

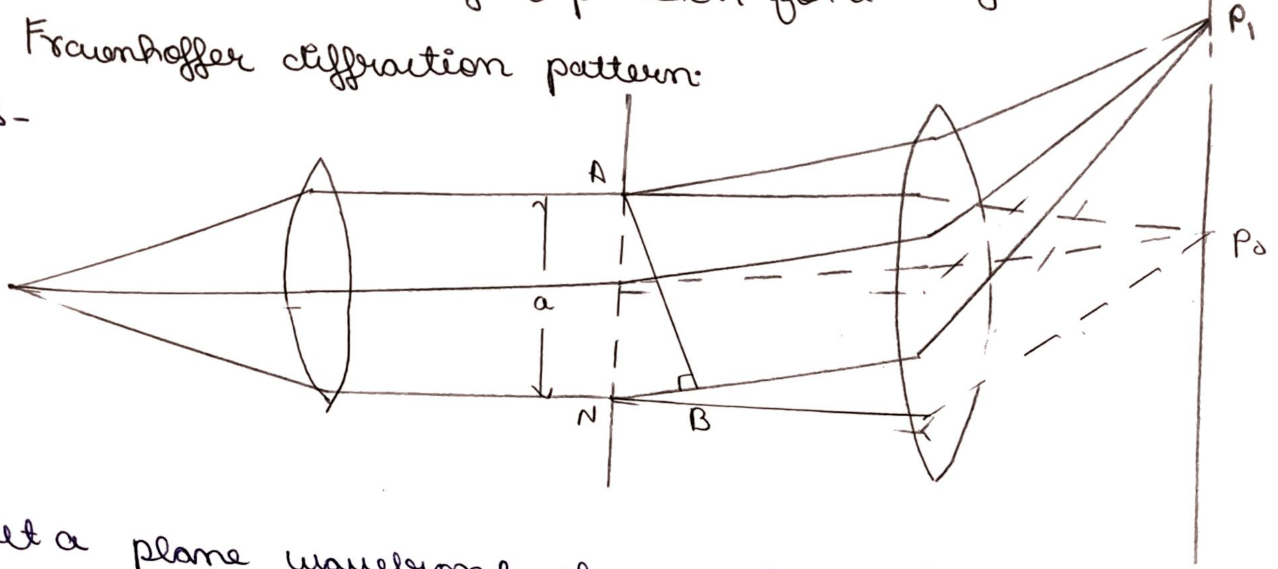
$$x' = \beta(x-vt)$$

$$\left.\begin{aligned} x' &= \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}(x-vt) \\ y' &= y \\ z' &= z \\ t' &= t \end{aligned}\right\}$$

These equations are known as Lorentz Equation.

2- obtain the intensity expression for a single slit Fraunhoffer diffraction pattern.

Ans -



Let a plane wavefront of monochromatic light of wavelength λ is propogating normally to slit AB then A/Q to Huygens theory every point within the slits become the source of secondary wavelets which spread out in all direction.

Path difference = BG $\sin\theta$ in ΔABN

$$\Delta = a\sin\theta \quad -(1)$$

Assume the slit is divided into 'n' equal parts so each part is source of secondary wavelets. the Amplitude of waves due to each part is equal to width of slit 'a' so the phase difference between the waves from any successive parts

$$\delta = \frac{1}{n}\left(\frac{2\pi}{\lambda} a\sin\theta\right) - (2)$$

Resultant Amplitude at P

$$R = \frac{a\sin\left(n\frac{\delta}{2}\right)}{\sin\left(\frac{\delta}{2}\right)}$$

So put the value of δ

$$R = \frac{a \sin\left(\frac{1}{\cancel{2}} \frac{2\pi}{\lambda} \times a \sin\theta \times \frac{\delta}{2} \times \cancel{n}\right)}{\sin\left(\frac{\cancel{2}\pi}{\cancel{d}\times\cancel{2}\times n} \times a \sin\theta\right)} \Leftrightarrow R = \frac{a \sin\left(\frac{\pi a}{d} \sin\theta\right)}{\sin\left(\frac{\pi}{nd} a \sin\theta\right)}$$

Let $\frac{\pi}{d} a \sin\theta = \alpha$

$$R = \frac{a \sin\alpha}{\sin\left(\frac{\alpha}{n}\right)}$$

for large value

$$\sin\left(\frac{\alpha}{n}\right) \cong \frac{\alpha}{n}$$

$$R = \frac{n a \sin\alpha}{\alpha}$$

Let $na = A$

$$\boxed{R = \frac{A \sin\alpha}{\alpha}} \quad \text{— (3)}$$

The Intensity of wave $\propto$ square of Amplitude

$$I = R^2$$

$$\boxed{I = \frac{A^2 \sin^2\alpha}{\alpha^2}}$$

3- Describe an optical fibre. What role does internal reflection play in light propogating through an optical fibre.

Ans →. optical fibres serve as cables to carry huge amount of information in the form of optical signals frome one place to another over a wide Band width with negligible loss. works on the principle of total internal reflection. incidence angle greater than critical angle. Incident ray reflect in same medium and this phonomona repeats.

- An optical fiber is a hair thin feasible transparent medium of cylindrical shape usually made of glass through which light can be propogated.

- The optical fiber has three principle sections such as

(i) Core
(ii) Cladding
(iii) Jacket

- The external angle of incidence made by a ray with a axis of the fiber, corresponding to the critical angle of incidence at the core-cladding boundary, is termed as acceptance angle. Thus, the critical angle determines the acceptance angle of the fibre.

- Acceptance angle is different for different fibres & depends on the core material and the core diameter

→ Let us consider the ray from air (refractive index n_0) is incident at an angle 'θ' on to the perpendicular end face of the fiber for which the angle of refraction is θ'.

Using Snell's law, we get

$$n_0 \sin\theta = n_1 \sin\theta'$$
$$= n_1 \sin(90 - \theta'')$$
$$= n_1 \cos\theta''$$

where θ'' is the angle of incidence on the fiber core-cladding interface.

If $\theta'' < \theta_c$ → ligh ray refracted

$\theta'' > \theta_c$ → light ray totally reflected at fiber.