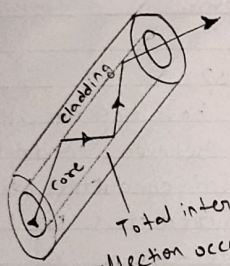
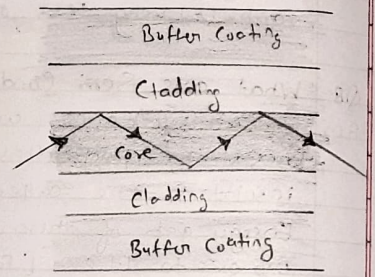
Diagram





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Experiment No. 7

Object :- To measure the Numerical Aperture of an Optical Fibre.

Aparatus :- Optical fibre, Circuit board or a Bread board containing fiber optic analogue transmitters and fiber optic analogue receiver circuits & IC regulated D.C. power supply.

Theory & formula :- If a light ray is incident on one of the fiber at an angle of α with the Normal, then it follows the snell's law

$$N_0 \sin\alpha_1 = N_1 \sin\alpha_2$$

where N_0 is the refractive index of the medium air. If N_1 & N_2 are the refractive indices of the material of the core & the cladding then for angle of incidence 'i' at the cladding layer.

$$i \geq i_c = \sin^{-1}(N_2/N_1)$$

$\sin i_c = N_2/N_1$ and numerical operature (NA) of the fiber is given by

$$NA = \sqrt{N_1^2 - N_2^2}$$

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Calculation

$$NA = \frac{W}{(4L^2 + W^2)^{1/2}}$$

(i) $NA_1 = \frac{8}{[4\times(69)^2 + (8)^2]^{1/2}}$

$NA_1 = 0.0578$

$\theta_1 = \sin^{-1}(0.0578)$

$\theta_1 = 3.31$

(ii) $NA_2 = \frac{12}{[4\times(93)^2 + (12)^2]^{1/2}}$

$NA_2 = 0.0643$

$\theta_2 = \sin^{-1}(0.0649)$

$\theta_2 = 3.72$

(iii) $NA_3 = \frac{16}{(4(121)^2 + (16)^2)^{1/2}}$

$NA_3 = 0.0659$

$\theta_3 = \sin^{-1}(0.0659)$

$\theta_3 = 3.77$

(iv) $NA_4 = \frac{20}{(4(144)^2 + (20)^2}$

$NA_4 = 0.0692$

$\theta_4 = \sin^{-1}(0.0692)$

$\theta_4 = 3.96$

(v) $NA_5 = \frac{24}{[4(165)^2 + (24)^2]^{1/2}}$

$NA_5 = 0.0725$

$\theta_5 = \sin^{-1}(0.0725)$

$\theta_5 = 4.157$

(vi) $NA_6 = \frac{28}{[4(187)^2 + (28)^2]^{1/2}}$

$NA_6 = 0.0746$

$\theta_6 = \sin^{-1}(0.0746)$

$\theta_6 = 4.278$

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$$NA = \frac{W}{[4L^2 + W^2]^{1/2}}$$

where L is the distance on the JIG (Platform on which observations could be made at different positions) where light emergent from the optical fiber in second. And W is the spread of the light spot observed on the screen. See fig depicting L & W.

Observations:-

S.No.	L (mm)	W (mm)	NA	θ (degrees)
1.	69	8	0.0578	3.31
2.	93	12	0.0643	3.72
3.	121	16	0.0659	3.77
4.	144	20	0.0692	3.96
5.	165	24	0.0725	4.157
6.	187	28	0.0746	4.278

Result:- The numerical aperture of the given optical fiber (at 650nm light) = 0.0673

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$$\theta_{mean} = \frac{3.31 + 3.72 + 3.77 + 3.96 + 4.15 + 4.27}{6}$$

$$\theta_{mean} = \frac{23.18}{6} = 3.863^{\circ}$$

At θ_{mean}

$NA = \sin\theta_{mean}$

$NA = \sin(3.863)$

$NA = 0.0673$ Ans

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Precautions:-

1. Attach the fiber optical cord properly
2. Distinguish the outer & inner pink light spots & thus make measurement of 'w'
3. Make sure that wavelength selected is 630 nm

Industrial Application:-

He-Ne laser is used widely in commercial and industrial applications & commonly used in laboratory demonstrations of optics. It is the most common laser used in holography. Other major applications of He-Ne laser include.

- Barcode scanners
- Tool alignment
- Non-contact measuring & monitoring
- Blood anyt. analysis
- Practicle counting & food sorting.
- Alignment of high power CO_2 & YAG treatment lasers & pointing beams.

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Ans (b) When mercury light passes through the grating it produces line spectrum while light from laser sources produces spots.
(c) Laser source higher order maxima can observed but ~~memory~~ mercury source have limit up to second order maxima.

Q5 Is He-Ne LASER is ~~four~~ four ~~Bio~~ energy level laser system?

Ans Yes, He-Ne LASER is four energy level system.

Q6 Give an example of three level laser.

Ans Ruby LASER.

Q7 Mention the basic characteristics of laser light source.

Ans LASER light is monochromatic, high intense, directional & coherent.

Q8 What is wavelength of light emitted from He-Ne Laser?

Ans The wavelength of light emitted by He-Ne laser is 6328 Å

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