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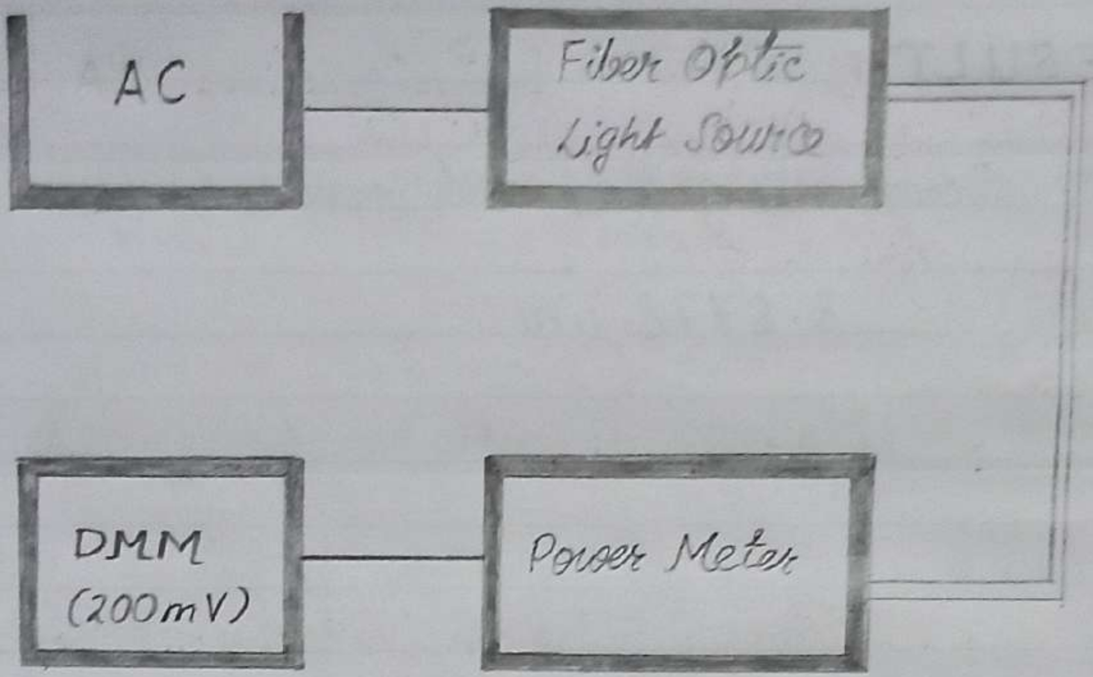

Setup for Loss Measurement

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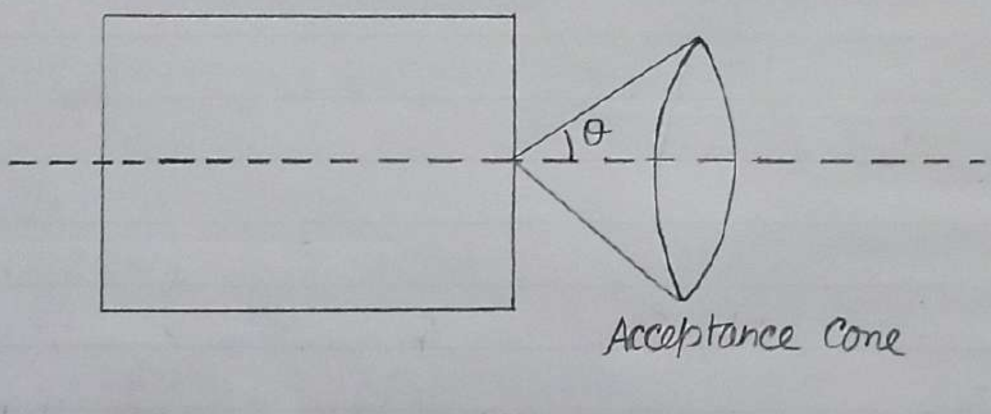

Numerical Aperture

Study of Attenuation and Propagation Characteristics of Optical Fibre Cable

I. Attenuation in Fibres :

AIM:

i) To determine the attenuation for a given optical fiber

ii) To measure the numerical aperture and hence the acceptance angle of the given fiber cables.

APPARATUS REQUIRED :

Fiber optic light source, optic power meter, and fiber cables (1m and 5m), Numerical aperture measurement JIG, optical fibre cable with source, screen.

PRINCIPLE :

The propagation of light down dielectric waveguides bears some similarity to the propagation of microwaves down the metal waveguides. If a beam of power P_i is launched into one end of an optical fiber and if P_f is the power remaining after a length L km has been traversed, then the attenuation is given by ;

DETERMINATION OF ATTENUATION FOR OPTICAL FIBER CABLES

$L = 4m = 4 \times 10^{-3}$ km

Source Level	Power output for 1m cable (P_i)	Power output for 5m cable (P_f)	Attenuation = $10[\log(P_i/P_f)]/L$ dB/km
Min	-52.8	-54.6	-36.3968
Max	-8.9	-10.3	-158.6180

CALCULATIONS:

At source level A i.e. Min :

$P_i = -52.8$; $P_f = -54.6$; $L = (5-1) = 4m$
$= 4 \times 10^{-3}$ km

So Attenuation $= 10[\log(P_i/P_f)]/L$

$= 10[\log(-52.8/-54.6)]/(4 \times 10^{-3}) = -36.3968$ dB/km

At Source level B i.e Max :

$P_i = -8.9$; $P_f = -10.3$; $L = (5-1) = 4m$
$= 4 \times 10^{-3}$ km

So Attenuation $= 10[\log(P_i/P_f)]/L$

$= 10[\log(-8.9/-10.3)]/(4 \times 10^{-3}) = -158.6180$ dB/km

$$\text{Attenuation} = 10[\log(P_i/P_f)]/L \ \text{dB/km}.$$

FORMULA :

$$\text{Attenuation} = 10[\log(P_i/P_f)]/L \ \text{dB/km}.$$

RESULT-I :

1. Attenuation at source level A = -36.3968 dB/km

2. Attenuation at source level B = -158.6180 dB/Km

II. Numerical Aperture :

PRINCIPLE

Numerical Aperture refers to the maximum angle at which the light incident on the fiber end is totally internally reflected and transmitted properly along the fiber. The cone formed by the rotation of this angle along the axis of the fiber is the cone of acceptance of the fiber.

FORMULA :

Numerical Aperture (NA) = $\frac{W}{\sqrt{4L^2 + W^2}} = \sin\theta_{max}$

Acceptance angle = $2\theta_{max}$ (deg)

where L = distance of the screen from the fiber end in meter
W = diameter of the spot in meter.

CALCULATIONS :

At A :- ① L = 10mm ; W = 10mm ;
(At 5m)

$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{10}{\sqrt{(4\times10^2)+10^2}} = 0.4472$

$\theta = \sin^{-1} 0.4472 = 26.564°$

② L = 12 mm ; W = 12 mm ;

$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{12}{\sqrt{(4\times12^2)+12^2}} = 0.4472$

$\theta = \sin^{-1} 0.4472 = 26.564°$

③ L = 14mm ; W = 14 mm ;

$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{14}{\sqrt{(4\times14^2)+14^2}} = 0.4472$

$\theta = \sin^{-1} 0.4472 = 26.564°$

Measurement of Numerical Aperture :

Circle	Distance betwn source and screen (L) (mm)	Diameter of the spot (W) (mm)	$NA = \frac{W}{\sqrt{4L^2 + W^2}}$	θ (deg)
5 m	10	10	0.4472	26.564
	12	12	0.4472	26.564
	14	14	0.4472	26.564
	16	17	0.4691	27.976
	18	19	0.4667	27.820
	Mean :		0.4555	27.098
1 m	10	11	0.4819	28.810
	12	12	0.4472	26.564
	14	15	0.4722	28.177
	16	18	0.4903	29.360
	18	19	0.4668	27.820
	Mean :		0.4717	28.146

CALLCULATIONS (cont.)

④ $L = 16\,mm$; $W = 17\,mm$;

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{17}{\sqrt{(4\times16^2)+17^2}} = 0.4691$$

$$\theta = \sin^{-1} 0.4691 = 27.976^\circ$$

⑤ $L = 18\,mm$; $W = 19\,mm$;

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{19}{\sqrt{(4\times18^2)+19^2}} = 0.4667$$

$$\theta = \sin^{-1} 0.4667 = 27.820^\circ$$

At B: (At 1m)

① $L = 10\,mm$; $W = 11\,mm$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{11}{\sqrt{(4\times10^2)+11^2}} = 0.4819$$

$$\theta = \sin^{-1} 0.4819 = 28.810^\circ$$

② $L = 12\,mm$; $W = 12\,mm$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{12}{\sqrt{(4\times12^2)+12^2}} = 0.4472$$

$$\theta = \sin^{-1} 0.4472 = 26.564^\circ$$

③ $L = 14\,mm$; $W = 15\,mm$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{15}{\sqrt{(4\times14^2)+15^2}} = 0.4722$$

$$\theta = \sin^{-1} 0.4722 = 28.177^\circ$$

④ $L = 16\,mm$; $W = 18\,mm$

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{18}{\sqrt{(4\times16^2)+18^2}} = 0.4903$$

$$\theta = \sin^{-1} 0.4903 = 29.360^\circ$$

⑤ $L = 18\,mm$; $W = 19\,mm$.

$$NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{19}{\sqrt{(4\times18^2)+19^2}} = 0.4668$$

$$\theta = \sin^{-1} 0.4668 = 27.820^\circ$$

RESULT-II :

(i) The numerical aperture of fiber is measured as :-

→ $5m = (0.4472 + 0.4472 + 0.4472 + 0.4691 + 0.4667)/5$
$= 0.4555$

→ $1m = (0.4819 + 0.4472 + 0.4722 + 0.4903 + 0.4668)/5$
$= 0.4717$

(ii) The acceptance angle is calculated as :-

→ $5m = (26.564 + 26.564 + 26.564 + 27.976 + 27.820)^\circ/5$
$= 27.098^\circ$

→ $1m = (28.810 + 26.564 + 28.177 + 29.360 + 27.820)^\circ/5$
$= 28.146^\circ$

Teacher's Signature ....

Expt.No.

Date. 08/12/20

FINAL RESULTS :

(I) (i) Attenuation at source level A = −36.3968 dB/km

(ii) Attenuation at source level B = −158.6180 dB/km

(II) (i) The numerical aperture of fibre is measured as

5m = 0.456

1m = 0.472

(ii) The acceptance angle is calculated as

5m = 27.098°

1m = 28.146°

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