EXP 9 : STUDY OF ATTENTUATION AND PROPAGATION CHARACTERISTICS OF OPTICAL FIBER CABLE

1. Attentuation in fibers.

Aim : i) To determine the attentuation for the 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 & 5m), Numerical aperture measurement JIG, optical fiber cable with source, screen.

Principle :

The propagation of light down dielectric waveguides bears some similarity to the propagation of microwaves down 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 attentuation is given by,

$$\text{Attentuation} = 10\left[\log\left(P_i/P_f\right)\right] / L \text{ dB/km}$$

Formula :

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

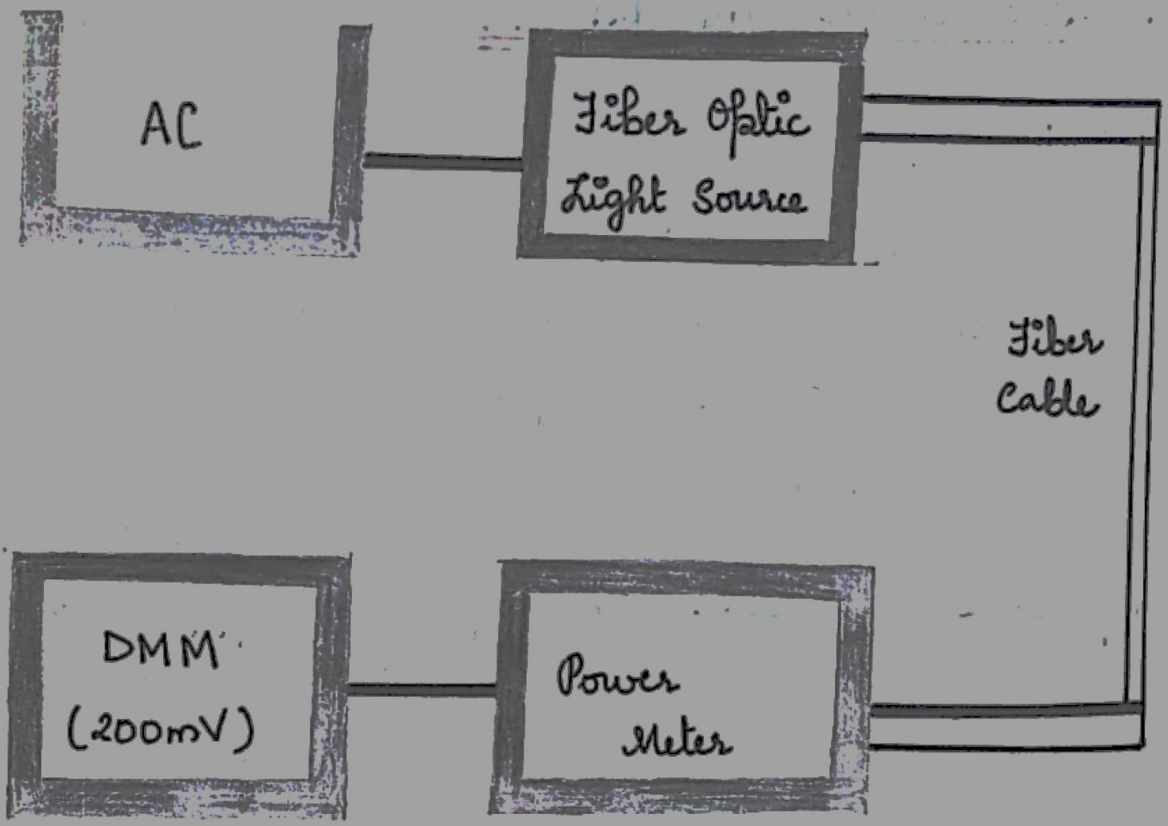

fig. Set-up for loss measurement

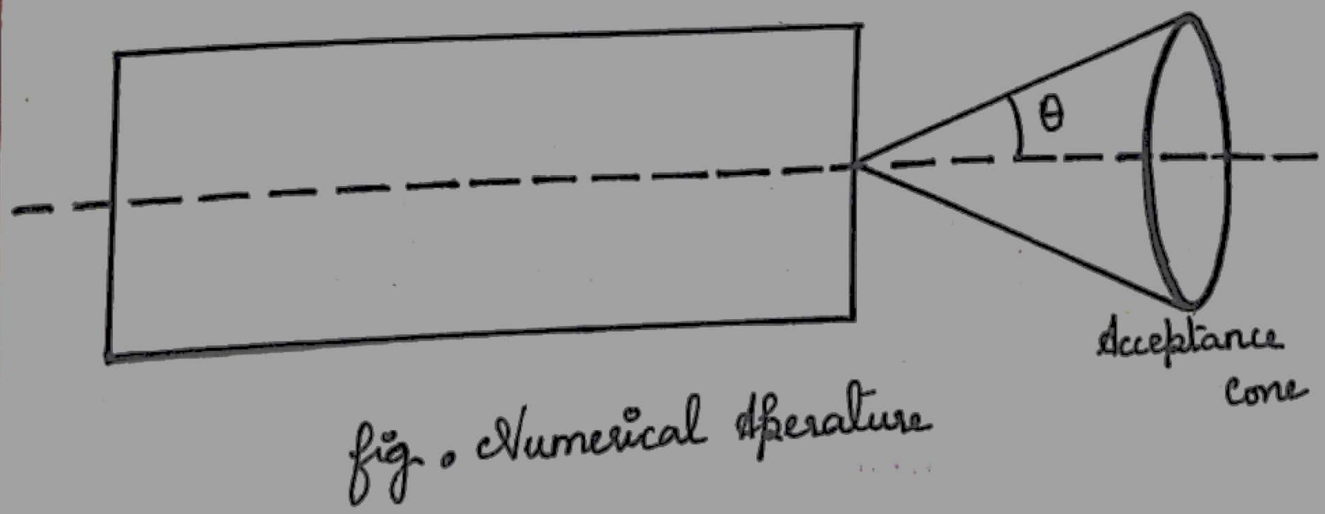

fig. Numerical Aperature

DETERMINATION OF ATTENTUATION FOR OPTICAL FIBER CABLES

Source Level	Power Output for 1m table (P_i)	Power Output for 5m cable (P_f)	Attentuation = $10\left[\log\left(\frac{P_i}{P_f}\right)\right]/L$ dB/km
Min	−32.2	−30.5	58.89
Max	−8.8	−7.4	188.12

MEASUREMENT OF NUMERICAL APERTURE

Circle	Distance b/w source & screen L (mm)	Diameter of the spot W (mm)	$NA = \frac{W}{\sqrt{4L^2+W^2}}$	θ
5m	10	11	0.4819	28.82
	20	19	0.4290	25.40
	30	29	0.4351	25.78
	40	39	0.4382	25.98
	Mean		0.4460	26.49
1m	10	10	0.4472	26.55
	20	19	0.4290	25.40
	30	27	0.4103	24.20
	40	39	0.4382	25.98
	Mean		0.4311	25.53

Calculations:

Determination of Attentuation

1. min:

$P_i = -32.2$

$P_f = -30.5$

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

$$\text{Attentuation} = \frac{10}{4 \times 10^{-3}} \cdot \log\left[\frac{P_i}{P_e}\right] \text{ dB/km}$$

$$= \frac{10}{4 \times 10^{-3}} \log\left[\frac{-32.2}{-30.5}\right]$$

$$= 2.5 \times 10^{3} \log\left(\frac{32.2}{30.5}\right)$$

$$= 58.89 \text{ dB/km}.$$

2. max:

$P_i = -8.8$

$P_f = -7.4$

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

$$\text{Attentuation} = \frac{10}{4 \times 10^{-3}} \log\left(\frac{-8.8}{-7.4}\right)$$

$$= 2.5 \times 10^{3} \cdot \log\left(\frac{8.8}{7.4}\right)$$

$:= 188 \text{ dB/km}$

Measurement of Numerical aperture

A] 5m

1. $L = 10$
   $W = 11$

$$NA_1 = \frac{W}{\sqrt{4L^2 + W^2}}$$

$$= \frac{11}{\sqrt{400 + 121}}$$

$$= 0.4819$$

$$\theta = \sin^{-1}(NA)$$
$$= \sin^{-1}(0.4819)$$
$$= 28.82$$

2. $L = 40$
   $W = 19$

$$NA_2 = \frac{19}{\sqrt{4(40)^2 + (19)^2}}$$

$$= 0.4290$$

$$\theta = \sin^{-1}(0.4290)$$

$$= \underline{25.40}$$

B] 1m

1. $l = 10$
   $w = 10$

$$NA_3 = \frac{10}{\sqrt{4(10)^2+(10)^2}}$$

$$= \underline{0.4472}$$

$$\theta = \sin^{-1}(0.4472)$$

$$= \underline{26.55}$$

2. $l = 40$
   $w = 39$

$$NA_4 = \frac{39}{\sqrt{4(40)^2+(39)^2}}$$

$$= \underline{0.4382}$$

$$\theta = \sin^{-1}(0.4382)$$

$$= \underline{25.98}$$

Mean

A] 5m

$$\text{mean} = \frac{NA_1 + NA_2 + NA_3 + NA_4}{4}$$

$$NA_{mean} = \frac{0.4819 + 0.4290 + 0.4351 + 0.4382}{4}$$

$$= 0.4460$$

$$\theta_{mean} = \frac{28.80 + 25.40 + 25.79 + 25.98}{4}$$

$$= 26.49$$

B] 1m

$$NA_{mean} = \frac{0.4472 + 0.4290 + 0.4103 + 0.4382}{4}$$

$$= 0.4311$$

$$\theta_{mean} = \frac{26.56 + 25.40 + 24.22 + 25.99}{4}$$

$$= 25.54$$

Result :

1. Attentuation at source level A [min] = 58.89 dB/km.
2. Attentuation at source level B [max] = 188.12 dB/km.
3. The numerical aperture of fiber is measured as:

   → 5m = 0.4460

   → 1m = 0.4311

4. The acceptance angle is calculated as:

   → 5m = 26.49

   → 1m = 25.54