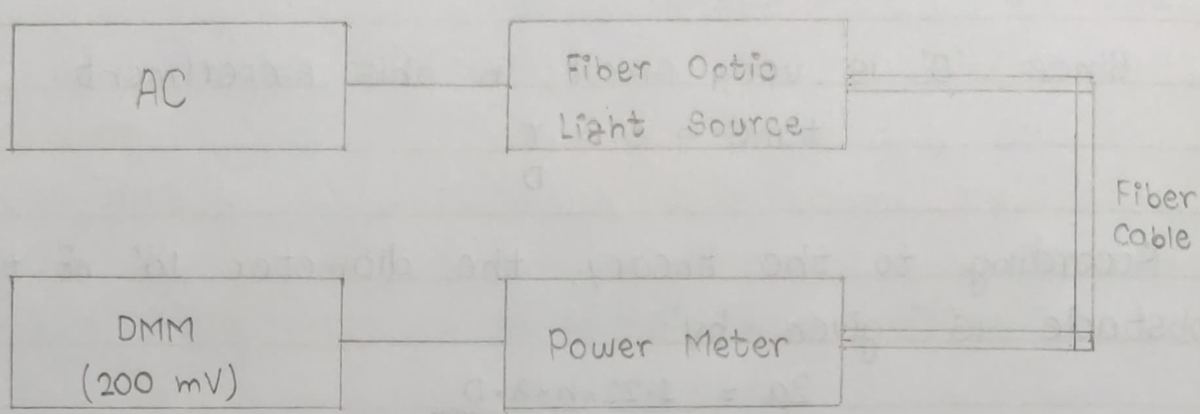
DIAGRAM $\Longrightarrow$



OBSERVATION $\Longrightarrow$

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

Source Level	Power output for 1m cable (P_i)	Power output for 5m cable (P_f)	Attenuation
			dB/km
Minimum	-27.8	-27.2	21.5
Maximum	-14.2	-12.9	103.25

CALCULATION $\Longrightarrow$

1) $$A = 10 \cdot \frac{\log(P_i/P_f)}{L} \quad \text{dB/km}$$

$$= 10 \cdot \frac{\log(27.8/27.2)}{4 \times 10^{-3}}$$

$$= 10 \cdot \frac{\log(1.02)}{4 \times 10^{-3}} = \frac{10 \times 0.0086}{4 \times 10^{-3}} = \frac{0.086}{4} \times 10^{3}$$

$$= 0.0215 \times 10^{3} = 21.5 \text{ dB/km}$$

STUDY OF ATTENUATION AND PROPAGATION CHARACTERISTICS OF OPTIC FIBER CABLE.

I. ATTENUATION IN FIBERS →

AIM ⟹

To determine the attenuation for the given optical fibre.

APPARATUS REQUIRED ⟹

Fiber optic, light source, optic power meter and fiber cables (1m and 5m), optic 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 transversed then, the attenuation is given by:

$$\text{Attenuation} = \frac{10 \cdot \log(P_i/P_f)}{L} \text{ dB/km}$$

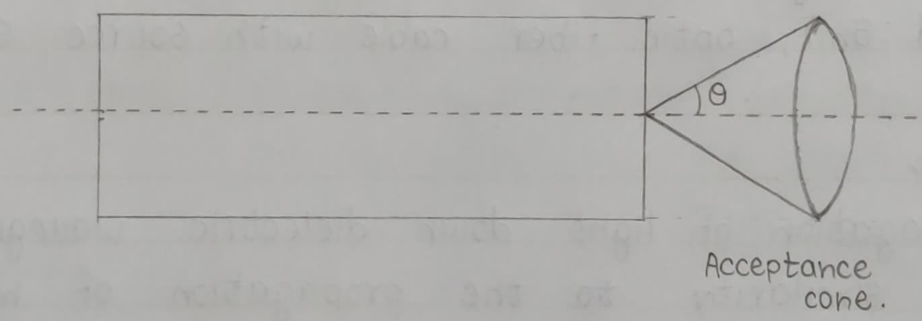
2) $A = 10 \cdot \frac{\log(P_i / P_f)}{L}$ dB/km

$= 10 \cdot \frac{\log(14.2 / 12.9)}{4 \times 10^{-3}}$

$= 10 \cdot \frac{\log(1.10)}{4 \times 10^{-3}} = \frac{10 \times 0.0413}{4 \times 10^{-3}} = \frac{0.413}{4} \times 10^{3}$

$= 0.10325 \times 10^{3} = 103.25$ dB/km

DIAGRAM ⟹



OBSERVATION ⟹

Circle	Distance between source and screen (L)	Diameter of the spot (W)	$NA = \frac{W}{\sqrt{4L^2 + W^2}}$	θ
	(mm)	(mm)		
	10	10	0.4472	26.5641
	12	12	0.4472	26.5641
5m	14	14	0.4472	26.5641

RESULT ⟶

1) Attenuation at source level A (min) = 21.5 dB/km

2) Attenuation at source level B (max) = 103.25 dB/km

II. NUMERICAL APERTURE ⟶

AIM ⟹

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, optic fiber cable with source, screen.

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.

	16	17	0.4692	27.9823
	18	19	0.4668	27.8267
		MEAN ⟶	0.4555	27.1002
1m	10	11	0.4820	28.8161
	12	12	0.4472	26.5641
	14	15	0.4722	28.1771
	16	18	0.4903	29.3603
	18	19	0.4668	27.8267
		MEAN ⟶	0.4717	28.1488

CALCULATIONS ⟹

· For 5m :

1) $L = 10mm$, $W = 10mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{10}{\sqrt{400+100}} = \frac{10}{\sqrt{500}} = \frac{10}{22.36}$$

$$= 0.4472$$

$$\text{and } \theta = \sin^{-1}(NA)$$
$$= \sin^{-1}(0.4472) = 26.5641$$

2) $L = 16mm$, $W = 17mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{17}{\sqrt{1024+289}} = \frac{17}{\sqrt{1313}} = \frac{17}{36.23}$$

$$= 0.4692$$

$$\text{and } \theta = \sin^{-1}(NA)$$
$$= \sin^{-1}(0.4692) = 27.9823$$

3) $L = 18mm$, $W = 19mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2+W^2}} = \frac{19}{\sqrt{1296+361}} = \frac{19}{\sqrt{1657}} = \frac{19}{40.70}$$

$$= 0.4668$$

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FORMULA →

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

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

where,

L = distance of the screen from the fiber end in metre.

W = diameter of the spot in metre.

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

$= \sin^{-1}(0.4668) = 27.8267$

so, the acceptance angle is $2\theta_{max}$

$= 2 \times 27.1002$

$= 54.2004^\circ$

- For 1m :

1) $L = 10mm$, $W = 11mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2 + W^2}} = \frac{11}{\sqrt{400 + 121}} = \frac{11}{\sqrt{521}} = \frac{11}{22.82}$$

$= 0.4820$

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

$= \sin^{-1}(0.4820) = 28.8161$

2) $L = 12mm$, $W = 12mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2 + W^2}} = \frac{12}{\sqrt{576 + 144}} = \frac{12}{\sqrt{720}} = \frac{12}{26.83}$$

$= 0.4472$

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

$= \sin^{-1}(0.4472) = 26.5641$

3) $L = 14mm$, $W = 15mm$

$$\therefore NA = \frac{W}{\sqrt{4L^2 + W^2}} = \frac{15}{\sqrt{784 + 225}} = \frac{15}{\sqrt{1009}} = \frac{15}{31.76}$$

$= 0.4722$

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

$= \sin^{-1}(0.4722) = 28.1771$

so, the acceptance angle is $2\theta_{max}$

$= 2 \times 28.1488$

$= 56.2976^\circ$

RESULT ⟹

1) The Numerical aperture of fiber is measured as 5m = 0.4555 mm, 1m = 0.4717 mm.

2) The acceptance angle is calculated as 5m = 54.2004°, 1m = 56.2976°.