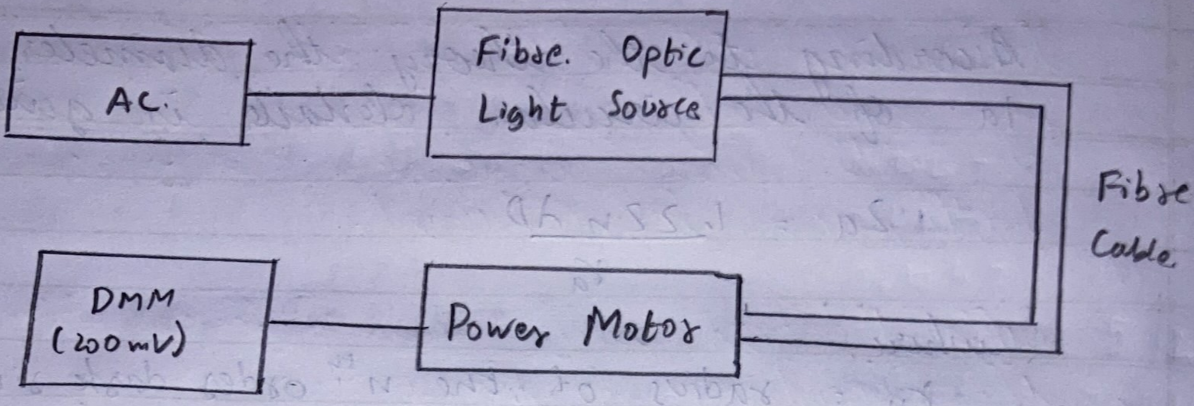
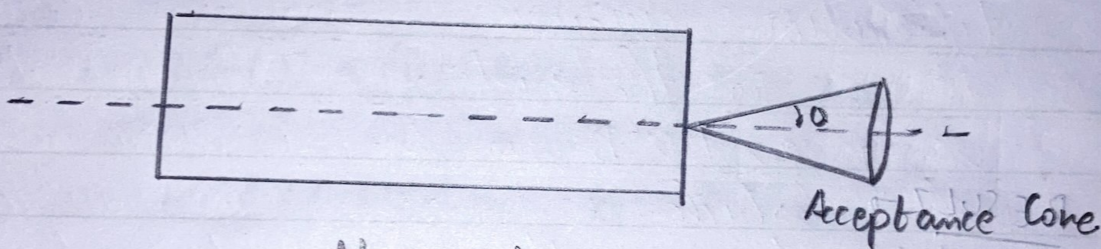
Experiment
Name ....



Setup for loss measurement



Numerical Aperture.

Determination of Attenuation for optical fibre 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
Min	-52.8	-54.6	-36.39
Max	-8.7	-10.3	-183.29

Teacher's Signature ....

STUDY OF ATTENUATION AND PROPAGATION CHARACTERISTICS OF OPTICAL FIBRE CABLE

I. ATTENUATION IN FIBRES

AIM :-

(i) To determine the attenuation for the given optical fibre.

(ii) To measure the numerical aperture & hence the acceptance angle of the given fibre cables.

APPARATUS REQUIRED -

Fibre optical light source, power meter & fiber cables (1m & 5m), Numerical aperture measurement JIG, optical fiber cable with source, screen.

Experiment

Name ....

Circle	Distance b/w screen & source (L) (mm)	Diameter of the Spot W (mm)	$NA = \frac{W}{\sqrt{4L^2+W^2}}$	θ
5m	10	10	0.447	53.10
	12	12	0.447	53.10
	14	14	0.447	53.10
	16	17	0.469	55.92
	18	19	0.466	55.55
	Mean		0.455	54.15
10m	10	11	0.482	57.62
	12	12	0.447	53.10
	14	15	0.472	56.22
	16	18	0.490	58.54
	18	19.	0.466	56.24
	Mean		0.471	56.36

CALCULATIONS :-

(i) $NA_1 = \frac{10}{\sqrt{4(100)+100}} = \frac{10}{10\sqrt{5}} = \boxed{0.447}$

$2\theta = 2\sin^{-1} 0.447 = \boxed{53.10^\circ}$

$NA_2 = \frac{12}{\sqrt{4(12)^2+(12)^2}} = \frac{12}{12\sqrt{5}} = \boxed{0.447}$

$2\theta = \boxed{53.10^\circ}$

(iii) $NA_3 = \frac{14}{\sqrt{(14)^2(1+4)}} = \frac{14}{14\sqrt{5}} = \boxed{0.447}$

$2\theta = 2\sin^{-1} 0.447 = \boxed{53.10^\circ}$

(iv) $NA_4 = \frac{17}{\sqrt{(16)^2 4 + 17^2}} = \frac{17}{36.23}$

$= 0.469.$

$2\theta = 2\sin^{-1} 0.469$

$= 55.92^\circ$

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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 of an optical fibre and if P_f is the final power remaining after a length L km has been traversed, then the attenuation is given by

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

FORMULA →

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

RESULT - I

(i) Attenuation at source level A = -36.39 (dB/Km)

(ii) Attenuation at source level B = -183.29 (dB/Km)

II. NUMERICAL APERTURE

PRINCIPLE -

Numerical aperture refers to the max. angle at which the light incident on the fibre end is totally internally reflected & transmitted properly along the fibre. The cone formed by the rotation of this angle along the axis of the fibre is the cone of acceptance of the fibre.

FORMULA →

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

Acceptance angle $= 2\theta_{max}$

where L → Dist of screen from fibre end in m
W → diameter of the spot in m.

RESULT →

Result 1:

(i) Attenuation at source level A = ~~0.455~~ -36.39 dB/Km
(ii) Attenuation at source level B = ~~0.6~~
-183.29 dB/Km

Result 2:

(i) The numerical aperture of fibre is measured as 5m = 0.455   1m = 0.471
(ii) The acceptance angle is calculated as
5m = 54.15°   1m = 56.36°

Experiment

Name ....

(v) $NA_5 = \frac{19}{\sqrt{4(18)^2+(19)^2}} = \frac{19}{18\sqrt{5}} = \boxed{0.466}$

$2\theta = 2\sin^{-1} 0.466 = \boxed{55.55^\circ}$

(vi) $NA_6 = \frac{11}{\sqrt{4(100)+121}} = \frac{11}{\sqrt{521}} = \boxed{0.482}$

$2\theta = \sin^{-1} 0.482 = \boxed{57.62^\circ}$

(vii) $NA_7 = \frac{12}{\sqrt{4(12)^2+(12)^2}} = \frac{12}{26.83} = \boxed{0.447}$

$2\theta = \sin^{-1} NA = \boxed{53.10^\circ}$

(viii) $NA_8 = \frac{15}{\sqrt{4(14)^2+(15)^2}} = \frac{15}{31.76} = \boxed{0.472}$

$2\theta = \sin^{-1} 0.472 = \boxed{56.22^\circ}$

(ix) $NA_9 = \frac{18}{\sqrt{4(16)^2+(18)^2}} = \frac{18}{36.71} = \boxed{0.490}$

$2\theta = 2\sin^{-1} 0.49 = \boxed{58.54^\circ}$

(x) $NA_{10} = \frac{19}{\sqrt{4(18)^2+(19)^2}} = \boxed{0.466}$

$2\theta = \sin^{-1} 0.466 = \boxed{56.29^\circ}$

Mean $NA_a = \frac{0.447+0.447+0.447+0.469+0.466}{5} = 0.4552$

Mean $NA_b = \frac{0.482+0.447+0.472+0.490+0.466}{5} = \boxed{0.471}$

Mean $2\theta_a = \frac{53.1+53.1+53.1+55.92+55.55}{5} = \boxed{54.15^\circ}$

Mean $2\theta_b = \frac{57.62+53.10+56.22+58.54+56.24}{5} = \boxed{56.36^\circ}$

Attenuation$_{min}$ $= \frac{10\log(P_i/P_f)}{L} = 10\log(-528/-54.6)/4\times10^{-3}$

$= \boxed{-36.39 \text{ dB/km}}$

Attenuation$_{max}$ $= \frac{10\log(P_i/P_f)}{L} = 10\log(-8.7/-10.3)/4\times10^{-3} = \boxed{-183.29 \text{ dB/km}}$

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