Date 24-09-2021

Expt. No. 1 Page No. 1

Experiment → Study of Attenuation and Propagation characteristics of optical fibre cable.

1. Attenuation of Fibres.

AIM

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

(II) To measure the numerical aperture and hence the acceptance angle of the given fibre cables.

APPARATUS REQUIRED

Fibre optic light source, optic power metre, fibre cables (1m & 5m), Numerical aperature 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

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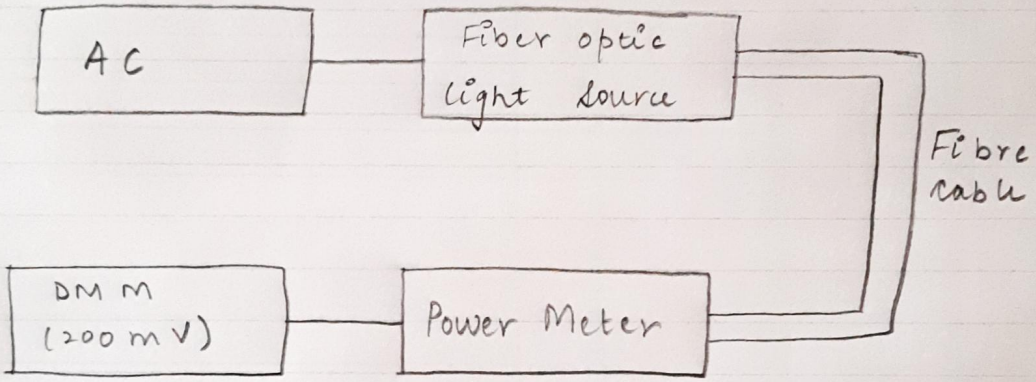

* Set up for loss measurement

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,

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

FORMULA

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

PROCEDURE

1. One end of the one metre fibre cable is connected to source and other end to the optical power metre.
2. Digital power metre is set to 200 mV range (-200 dB) and the power metre is switched on.
3. The ac main of the optic source is switched on and the fiber patch cord knob in the source is set at once level (A).

→

* Determination of Attenuation for optical fibre cables.

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

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

Source level	Power output for 1 m cable (P_i)	Power output for 5m cable (P_f)	Attenuation (dB/km) = $\frac{10 \log [P_i/P_f]}{L}$
Min	−27.8	−27.2	$= \frac{10 \log [-27.8/-27.2]}{4 \times 10^{-3}}$ $= \frac{0.009 \times 10}{0.004} = \frac{94}{4}$ Attenuation = 23.5 dB/km
Max	−14.2	−12.9	$= 10 \log [-14.2/-12.9]$ $= \frac{0.41}{0.004} = 102.5$ dB/km Attenuation = 102.5 dB/km

* Result :-

1) Attenuation at source level A = 23.5 dB/km

2) Attenuation at source level B = 102.5 dB/km

4. The digital power meter ~~is~~ reading is noted (P_i)
5. The procedure is repeated for 5m cable (P_f)
6. The experiment is repeated for different source levels.

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 property along the fiber. The cone formed by the rotation of this angle along the axis of the fiber is the cone of acceptance of fiber.

Formula

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

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

where,

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

W = diameter of the spot in metre.

Procedure

1. One of end of 1m fiber cable is connected to the source and the other end to the NA jig.
2. The AC mains are plugged. Light must appear at the end of the fiber on the NA jig. The set knob in source is turned clockwise to set to a maximum output.
3. The white screen with four concentric circles (10, 15, 20, 25 mm diameters) is held vertically at a suitable distance to make the red spot from the exiting fiber coincide with the 10mm circle.
4. The distance of the screen from the fiber end L is recorded and the diameter of the spot W is noted. The diameter of the circle can be accurately measured with the scale. The procedure is repeated for 15 mm, 20 mm and 25 mm diameter circles.

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Date .....

Expt. No. .....

5. The readings are tabulated and the mean numerical aperature and acceptance angle are determined.

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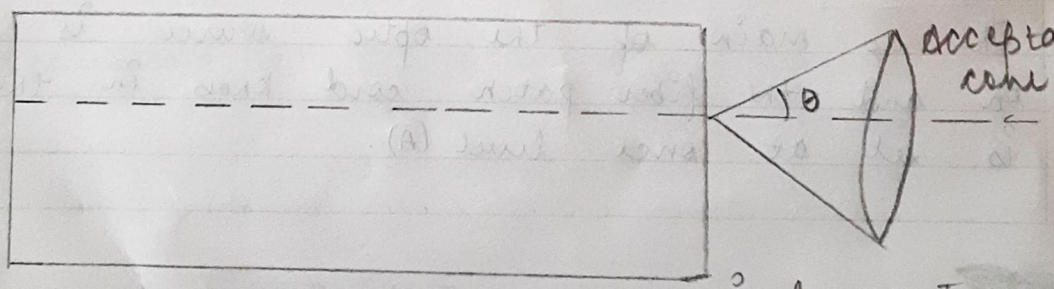
* Measurement of Numerical Aperature

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

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	10	0.447	26.10
	12	12	0.447	26.10
	14	14	0.447	26.10
	16	17	0.469	27.98
	18	19	0.466	27.77
For 5m circle	• Mean of Numerical aperture = 0.473		Mean of θ = 26.80	
Circle	L	W	NA	θ
1m	10	11	0.481	28.75
	12	12	0.447	26.55
	14	15	0.472	28.16
	16	18	0.490	29.34
	18	19	0.466	27.77
Mean of (For 1m) Numerical aperature = 0.4712			Mean of θ = 28.114	



• Numerical aperture

* Acceptance angle

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

For 5m:

θ_{max} = 27.96 (deg)

Acceptance angle = 55.92 (deg)

For 1m:

θ_{max} = 29.34 (deg)

Acceptance angle = 2 X 29.34

= 58.68 (deg)

* Result

1) Numerical aperture of fiber is measured as:

5m = 0.473

1m = 0.4712

2) Acceptance angle is calculated as:

5m = 55.92 (deg)

1M = 58.68 (deg)