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ECE – A

Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics- 18PYB101J

EXPERIMENT - 11

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STUDY OF ATTENUATION AND PROPAGATION CHARACTERISTICS OF OPTICAL FIBER CABLE

AIM:

i) To determine the attenuation 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 and 5m), numerical aperture, measurement JIG, optical fiber cable with source, screen.

PRINCIPLE:

The propogation of light down dielectric waveguides bears some similarity to the propagation of microwaves down metal wave guides. 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.

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

Also from NA, $\theta = \sin^{-1}(NA)$.

OBSERVATION:

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

CALCULATIONS:

(i) Attenuation at source level minimum,

$= 10 \log[-27.8 / -27.2] / L$

$= \cancel{0.0236}$ dB/km

23.6

(ii) Attenuation at source level maximum,

$= 10 \log (-14.2 / -12.9) / L$

$= \cancel{0.1042}$ dB/km
104.2

(iii) Numerical Aperture $= \dfrac{W}{\sqrt{4L^2 + W^2}}$ and $\theta = \sin^{-1}(NA)$.

For 5m,

i) $NA = \dfrac{10}{\sqrt{4 \times 10^2 + 10^2}} = 0.4472$; $\theta = \sin^{-1}(0.4472)$
$= 26.5°$.

ii) $NA = \dfrac{12}{\sqrt{4 \times 12^2 + 12^2}} = 0.4472$; $\theta = \sin^{-1}(0.4472)$
$= 26.5°$

iii) $NA = \dfrac{14}{\sqrt{4 \times (14)^2 + 14^2}} = 0.4472$; $\theta = \sin^{-1}(0.4472)$
$= 26.5°$.

iv) $NA = \dfrac{17}{\sqrt{4 \times 16^2 + 17^2}} = 0.4691$; $\theta = \sin^{-1}(0.4691)$
$= 28°$.

v) $NA = \dfrac{19}{\sqrt{4 \times 18^2 + 19^2}} = 0.4667$; $\theta = \sin^{-1}(0.4667)$
$= 27.8°$.

Mean $NA = \dfrac{0.4472 + 0.4472 + 0.4472 + 0.4691 + 0.4667}{5}$

$= 0.4555$.

Mean $\theta = \dfrac{26.5 + 26.5 + 26.5 + 28 + 27.8}{5}$

$= 27.6°$.

For 1m:

i) $NA = \dfrac{11}{\sqrt{4 \times 10^2 + 11^2}} = 0.4819$; $\theta = \sin^{-1}(0.4819) = 28.8°$

ii) $NA = \dfrac{12}{\sqrt{4 \times 12^2 + 12^2}} = 0.4472$; $\theta = \sin^{-1}(0.4472) = 26.5°$.

iii) $NA = \frac{15}{\sqrt{4\times14^2+15^2}} = 0.4722$; $\theta = \sin^{-1}(0.4722) = 28.1°$.

iv) $NA = \frac{18}{\sqrt{4\times18^2+18^2}} = 0.4902$; $\theta = \sin^{-1}(0.4902) = 29.3°$.

v) $NA = \frac{19}{\sqrt{4\times18^2+19^2}} = 0.4667$; $\theta = \sin^{-1}(0.4667) = 27.8°$.

$$\text{Mean NA} = \frac{0.4819 + 0.4472 + 0.4722 + 0.4902 + 0.4667}{5} = 0.4715$$

$$\text{Mean } \theta = \frac{28.8 + 26.5 + 28.1 + 29.3 + 27.8}{5}$$

$$= 28.1°.$$

RESULT:

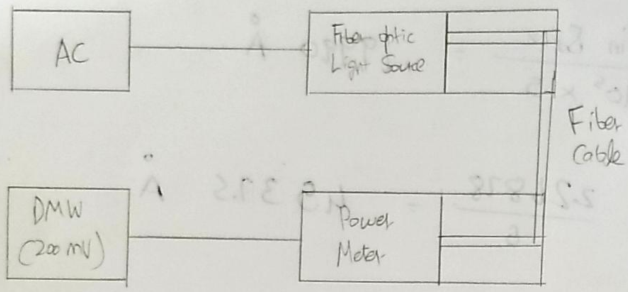
(i) Attenuation at source level; minimum = ~~0.0236~~ 23.6 dB/km

(ii) Attenuation at source level; maximum = ~~0.1042~~ 104.2 dB/km.

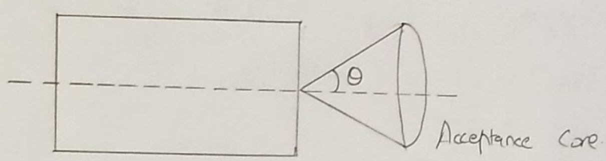
(iii) The numerical aperture of fiber is measured as 5m = 0.4555
1m = 0.4715

(iv) The acceptance angle is calculated as 5m = 27.6°
1m = 28.1°

STUDY OF ATTENUATION AND PROPAGATION CHARACTERISTICS OF OPTICAL FIBER CABLE



Setup for Loss Measurement.



Numerical Aperture.

Table for Determination of Attenuation for optical fiber Cables.

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	-27.8	-27.2	23.6
Max	-14.2	-12.9	104.2

Table for Measurement of Numerical Aperture.

Circle	Dist. between Source and Screen - L (mm)	Diameter of the Spot - W (mm)	$NA = \frac{W}{\sqrt{4L^2+W^2}}$	θ
5m	10	10	0.4472	26.5°
	12	12	0.4472	26.5°
	14	14	0.4472	26.5°
	16	17	0.4691	28°
	18	19	0.4667	27.8°
1m	10	11	0.4819	28.8°
	12	12	0.4472	26.5°
	14	15	0.4722	28.1°
	16	18	0.4902	29.3°
	18	19	0.4667	27.8°