
Experiment No.:- 02 **Date:-** 22/06/2021

STUDY OF NUMERICAL APERTURE OF AN OPTICAL FIBRE

(Module 1)

DJ19FEC202.1: Apply the foundations of Optics and Photonics in development of modern communication technology.

AIM: - To measure the numerical aperture of the plastic optical fibre by using 660 nm wavelengths LED.

APPARATUS:- The fibre optic trainer kit , numerical aperture jig, one side open half meter optical fibre cable ,scale.

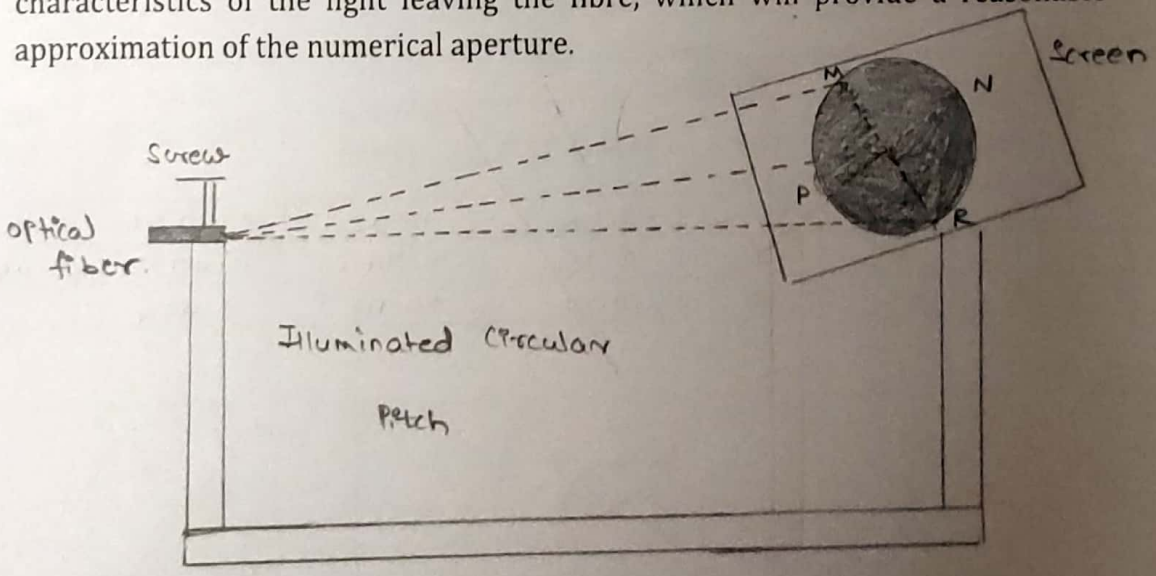
THEORY: - Numerical aperture refers to the sine of maximum angle which at which the light incident on the optical fibre end is totally reflected and is transmitted properly along the fibre. The cone formed by the rotation of this angle about the axis of the fibre is the cone of acceptance of the fibre.

The numerical aperture of a fibre = NA = $\sqrt{n_1^2 - n_2^2}$

Where, n_1 is the maximum refractive index of the core

n_2 is the refractive index of the cladding

Though the numerical aperture is a parameter associated with light entering a optical fibre, however to measure numerical aperture it is easier to investigate the characteristics of the light leaving the fibre, which will provide a reasonable approximation of the numerical aperture.



NUMERICAL APERTURE MEASURMENT SETUP

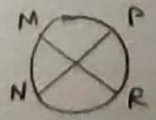
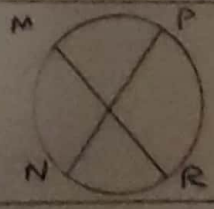
PROCEDURE:-

1. Connect the power cord of transmitter kit to mains supply and switch on.
2. Select the Digital/Analog switch for Digital transmission. Keep Low-Hi switch in high position.
3. With the help of jumpers connect the Digital data generator to LED driver, and LED driver to LED (660 nm).
4. Connect the optical fiber to LED. Insert the other end of the optical fibre into the numerical aperture measurement jig. The inserted position of the optical fiber should be perfectly straight.
5. Adjust the fiber in such a way that its tip is approximately 5 mm above from the screen. Now observe the illuminated circular patch of light on the screen. Measure the diameter of the illuminated circular patch in two mutually perpendicular directions. The radius of the circular patch is given by, $r = (MR + PN)/4$.
6. Measure the distance "d" between the tip of the fibre and the screen carefully.
7. The numerical aperture (N.A.) is equal to $r/(r^2+d^2)$. Calculate it.
8. Repeat procedures (5) to (7) for different values of d.
9. Calculate the average value of numerical aperture.

OBSERVATIONS:-

Refractive index of core (n_1) = 1.492
Refractive index of the cladding (n_2) = 1.406
Numerical Aperture (N.A.) = $\sin \Phi_m$ = 0.4996

Sr.No.	"d" (mm)	"r" (mm)			$(r^2+d^2)^{1/2}$ (mm)	N.A.= $r/(r^2+d^2)^{1/2}$	Mean N.A.
		MR	PN	(MR+PN)/4			
1.	13	10	11	5.25	14.02	0.3744	
2.	7	8	7	3.75	7.9411	0.4722	0.4505
3.	18	21	20	10.25	20.713	0.494	

		
d = 13mm	d = 7mm	d = 18mm

RESULT: - Theoretical value of numerical aperture = $\sqrt{n_1^2 - n_2^2}$ = 0.4996.

Experimental value of numerical aperture = 0.4505

COMMENTS:-

1. Mention any two advantages of optical fibre communication over conventional communication.

Advantages of optical fibre communication over conventional communication:

1) It has faster speed with less attenuation.
2) It is less impervious to electromagnetic interference.
3) It has smaller size and greater information carrying capacity.

2. If refractive index of core (n_1) is 1.502 and that of cladding (n_2) is 1.395, find the Numerical Aperture (N.A.) and acceptance angle.

N.A. = $\sqrt{n_1^2 - n_2^2} = \sqrt{1.502^2 - 1.375^2}$ $\therefore$ NA = 0.5567

Acceptance angle (θ) = $\sin^{-1}(N.A.) = \sin^{-1}(0.5567)$

$\therefore \theta = 33.828°$

D.J.S.C.E. (Physics)		
Journal		
Knowledge	3	
Documentation	3	
Punctuality	3	
Virtual Lab (Performance & Documentation)	6	
Total	15	

Date	Signature of the faculty