Experiment No. 6

Aim: - To determine numerical aperture of an optical fibre.

List of Equipment Used:
Table 1: List of Equipments

S.N.	Equipment	Range	Quantity
1.	Power supply	0-12V	1
2.	Emitter/laser	650nm	1
3.	Concentrator	NA	1
4	Optical Fiber	NA	2
5	Detector	NA	1
6	Output unit	2μA	1

Introduction/Theory: Numerical aperture is a basic descriptive characteristic of a specific fiber. It is represents the size or degree of openness of the input acceptance cone. Mathematically it is defined as the sine half angle of the acceptance cone.

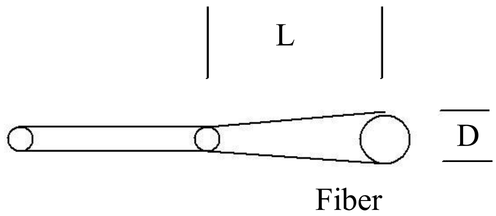
Using Snell's law, the maximum angle within which light will be accepted into and guided through fiber is

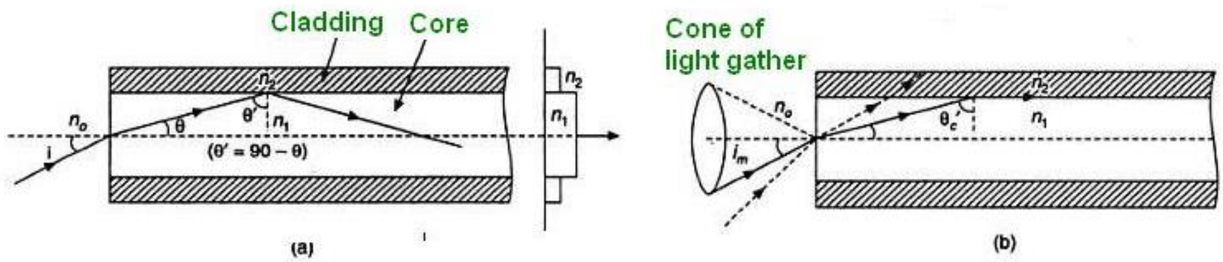
$$NA = \text{Sin}\left(\theta_a\right) = \quad (n_1^2 - n_2^2)^{1/2}$$

Where θ_a is the numerical aperture and n_1 and n_2 are the refractive indices of the core and the Cladding. If the incident angle $\theta < \theta_a$, the ray undergoes multiple internal reflections at core and cladding interface and it is called the guided ray. If $\theta_a < \theta$, the ray undergoes only partial reflection at core cladding interface.

In short length of straight fiber, ideally a ray launched at angle θ at the input end should come out at the same angle θ from output end. Therefore, the far field at the output end will also appear as a cone of semi angle θ_a emanating from the fiber end.

Diagram:





Formula Used: NA= $\text{Sin}\theta_a = \frac{r}{\sqrt{r^2+z^2}}$

Acceptance angle: $\theta_a = \text{Sin}^{-1}(\frac{r}{\sqrt{r^2+z^2}})$

Precautions:

1. Optical source should be properly aligned with the cable.
2. Distance of the launch point from cable should be properly selected to ensure that maximum amount of optical power is transferred to the cable.
3. The optical fiber provided should be handled carefully so as to prevent cracks.

Controls for simulator

- Start button: To start the experiment.
- Switch on: To switch on the Laser.
- Select Fiber: To select the type of fiber used.
- Select Laser: To select a different laser source.
- Detector distance (Z): Use the slider to vary the distance between the source and detector.
- Detector distance(x): Use the slider to change the detector distance i.e. towards left or right w.r.t the fiber.
- Show Graph: To displays the graph.
- Reset: To resets the experimental arrangement.

Procedure:

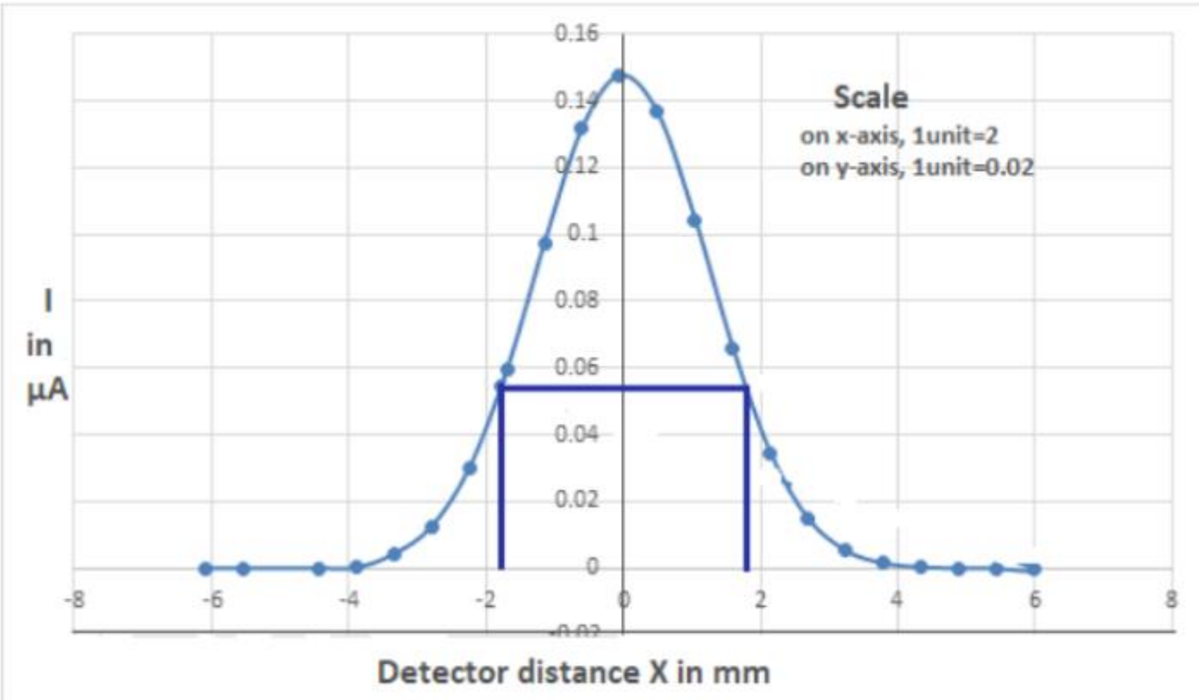
- Set the detector distance Z (say 4 mm).
- Vary the detector distance X by an order of 0.5 mm, using the screw gauge.
- Measure the detector reading from output unit and tabulate it.
- Plot the graph between X in x-axis and output reading in y-axis.
- Find the radius of the spot r, which is corresponding to Imax/2.71.
- Then find the numerical aperture of the optic fiber using the equation (1)

Observations& Calculations:
Table2:

S.No.	Distance x in (mm)	Current I in (mm)
1		
2		
3		

Numerical aperture of Optical fiber = ________

Graph:



Result(s): Numerical aperture of the given Optical fiber =

Conclusion: -A high numerical aperture allows light to propagate down the fiber in rays both close to the axis and at various angles, allowing efficient coupling of light into the fiber. However, a high numerical aperture increases theamount of dispersion as rays at different angles have different path lengths and therefore takedifferent times to traverse the fiber. A low numerical aperture may therefore be desirable.