EXPERIMENT - 1

DETERMINATION OF NUMERICAL APERTURE OF OPTICAL FIBERS

OBJECTIVES:

To determine the numerical aperture of the PMMA FIBER cables included with this FO1.

BASIC DEFINITIONS:

Numerical aperture of any optical system is a measure of how much light can be collected by the optical system. It is the product of the refractive index of the incident medium and the sine of the maximum ray angle.

$NA = n_i . \sin\theta_{max}$; Ni for air is 1, hence $NA = \sin\theta_{max}$;

For a step-index FIBER, as in the present case, the numerical aperture is given by

$N = \sqrt{(n_{core}^2 - n_{cladding}^2)}$

For very small differences in refractive indices the equation reduces to

$$NA = n_{core} \sqrt{(2\Delta)},$$

Where;

Δ is the fractional difference in refractive indices

The fiber may refer to the specifications of the PMMA FIBER given in appendix-1 and record the manufacturer's NA, $n_{cladding}$ and n_{core} andθ.

STEP-BY-STEP PROCEDURE: (WITH BLOCK SCHEMATIC)

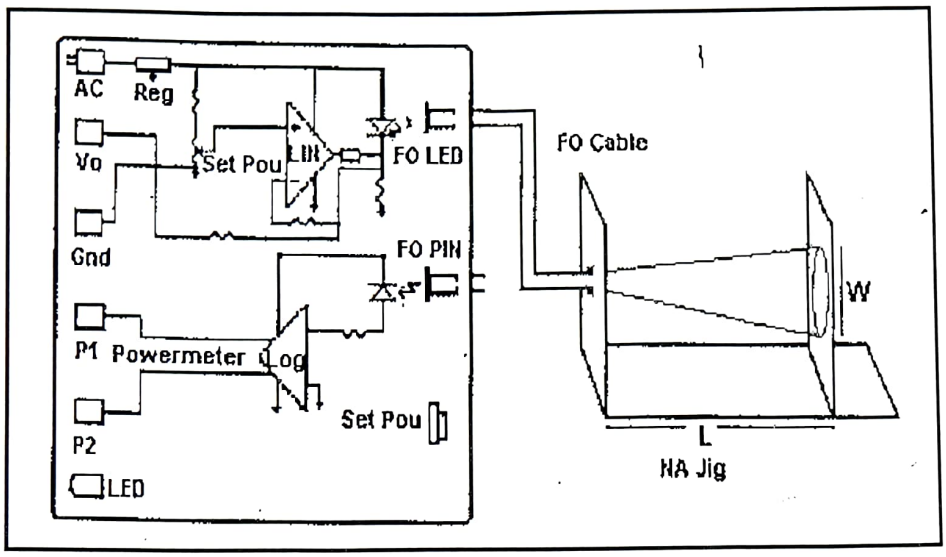

FIGURE – 2: THE SCHEMATIC OF THE NUMERICAL APERTURE MEASUREMENT SYSTEM

1. Connect one end of the Cable 1 (1-meter FO cable) to FO LED in the FIBER Optic LED driver section of FO1 and the other end to the NA Jig, as shown in figure - 2.
2. Switch On the trainer. Light should appear at the end of the FIBER on the NA Jig. Turn the **Set P_{out}** knob clockwise to set to maximum Po. The light intensity should increase.
3. Hold the white screen with the concentric circles (5, 10, 15, 20 and 25mm diameter) vertically at a suitable distance to make the red spot from the emitting FIBER coincide with the 10 mm circle. Note that the circumference of the spot (outermost) must coincide with the circle. A dark room will facilitate good contrast. Record "**L**" the distance of the screen from the FIBER end and note the diameter) of the spot. You may measure the diameter of the circle accurately with a suitable scale.
4. Compute NA from the formula;

$$NA = \sin\theta_{max} = W/(4L^2+W^2)^{1/2}$$

Tabulate the reading and repeat the for 15mm, 20mm and 25 mm diameters too.

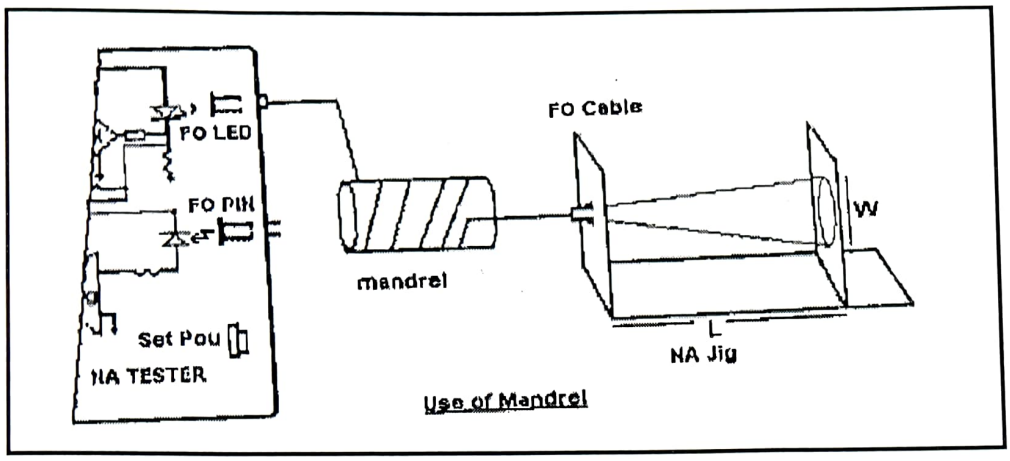

FIGURE – 3

5. In case the FIBER is under filled, the intensity within the spot may not be evenly distributed. To ensure even distribution of light in the FIBER, first remove twists on the FIBER and then wind 5 turns of the FIBER on to the mandrel as shown in figure-3. Use an adhesive tape to hold the windings in position. Now view the spot. The intensity will be more evenly distributed within the core.

TABLE -1

S. No	L (mm)	W(mm)	NA	θ (degrees)
1	10	10	0.447	26.5
2	16	15	0.423	25.0
3	20	20	0.447	26.5
4	26	25	0.432	25.64
5	30	-	-	-

DISCUSSION:

The numerical aperture as recorded in the manufacturer's data sheet is 0.5 typically the value measured here is 0.437. The lower reading recorded is mainly due to the FIBER being under filled. The acceptance angle is given by $2\theta_{max}$. The value of 52 degrees recorded in this is close to the range of 55-60 degrees. The lower reading is again due to the FIBER being under filled.

WIRING DIAGRAM

SECTION II

EXPERIMENT- 1