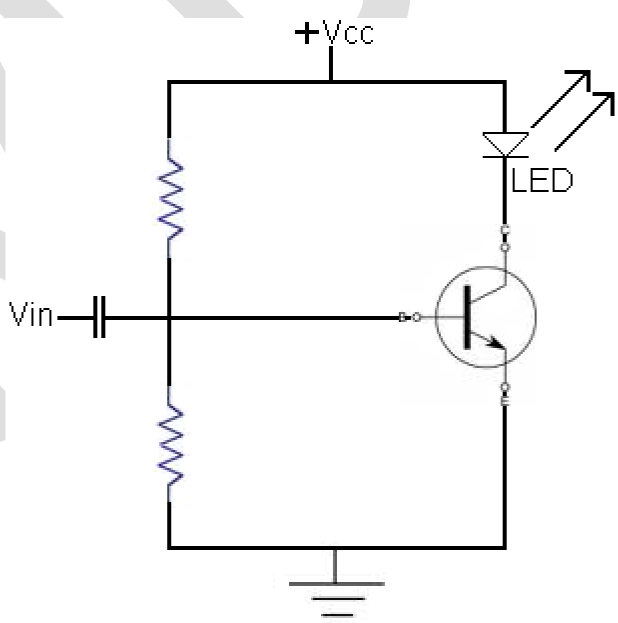
FIBER OPTICS

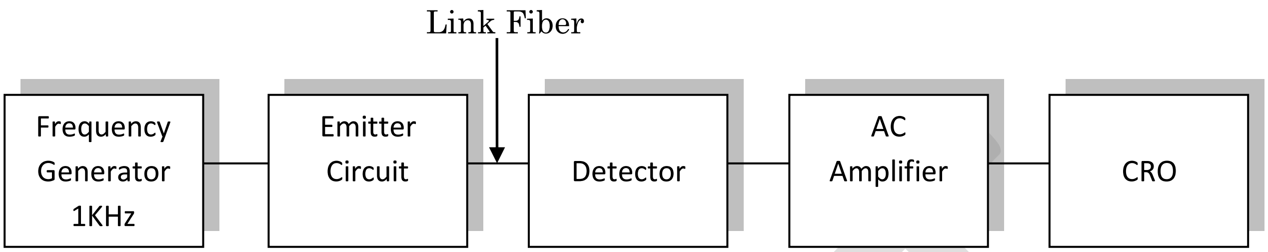
Experiment No. 8(A)

Objective:	Study of 650nm fiber optic analog link. In this experiment you will study the relation between input signal & received signal.
Equipment Needed:	Fiber optic trainer kit, fiber optic cable, CRO, etc
Theory:	Fiber optic links can be used for transmission of digital as well as analog signals. Basically a fiber optic link contains three main elements, a transmitter, an optical fiber and a receiver. The transmitter module takes the input signal in electric form and then transform into optical (light) energy containing the same information. The optical fiber is medium, which takes the energy to the receiver. At receiver light energy is converted back to the electrical form with same pattern as originally fed to the transmitter.
Procedure:	
1.	Connect the power supply to the board.
2.	Ensure that all switch faults are OFF.
3.	a.) Connect the function generator 1 KHz sine wave output to emitter input.
	b.) Connect the fiber optic cable between emitter output and detector input.
	c.) Connect the detector output to AC amplifier input.
4.	On the board, switch SW1 emitter driver to analog mode.
5.	Switch on the power supply.
6.	Observe the input to emitter (TP5) with the out from AC amplifier (TP19) and note that the two signals are the same.

Circuit Diagram:



Block Diagram:



Observation Table:

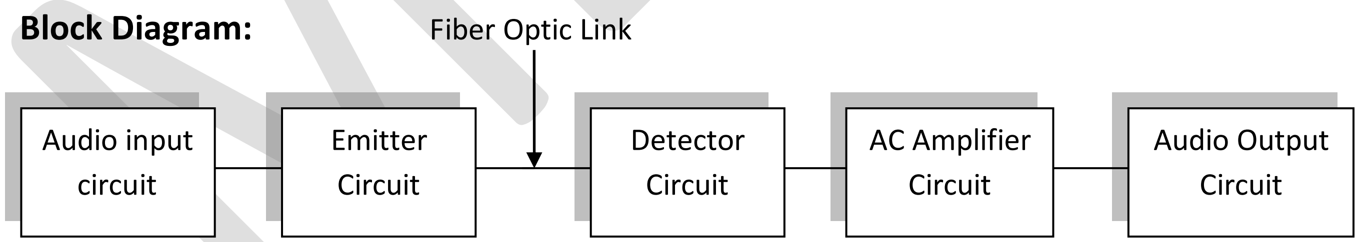
Sr. No.	Input Signal	Output Signal
1.	1V	0.8V

Result:	From above observation table we can say that, the signals which are fed to the transmitter are of the same pattern with the signals which are received from the receiver.

Experiment No. 8(B)

Objective:	Study of Voice Communication through fiber optic cable using amplitude modulation.
Equipments Needed:	Microphone, Fiber optic trainer kit, Head phone, Connecting wires.
Procedure:	
1	Connect the power supply to the board.
2.	a). Connect the audio input block input to microphone.
	b). Plug in a fiber optic link from output of emitter LED to the photo transistor of the detector.
	c). Connect the detector output (TP8) to input of amplifier TP18.
	d). Connect the output of audio input block to emitter input.
	e). Connect the ac amplifier output to input of audio output block.
3.	On the board, switch SW1 emitter driver to analog mode.
4.	Turn the 1KHz preset in function generator block to fully clockwise (maximum amplitude) position.
5.	Switch on the power supply.
6.	With the help of dual trace oscilloscope observe the input signal at emitter (TP5). Also observe the output from the detector. It should carry a smaller version of the original 1 KHz sine wave, illustrating that the modulated light beam has been reconverted into an electrical signal.
7.	The output from detector is further amplified by AC amplifier. This amplifier increases the amplitude of the received signal, and also removes the DC component, which is present at detector output. Monitor the output of amplifier (TP19) and adjust the gain adjust preset until the monitored signal has some amplitude as the applied to emitter input (TP5).
8.	While monitoring the output of amplifier TP19 change the amplitude of modulating sine wave by varying the 1 KHz preset in the function generator block. Note that as expected, the amplitude of the receiver output signal changes.
9.	Observe that same audio output is available on the speaker as fed to the microphone.

Block Diagram:



FIBER OPTICS

Experiment No. 8(B)

Objective:	Study of Bending loss and measurement of propagation or attenuation loss in the optical fiber.
Equipments Needed:	Fiber optic trainer kit, Mandrel, CRO, Fiber optic cable, Connecting cables.
Theory	**<u>Loss Due to Bending:</u>** Whenever the condition for angle of incidence of incident light is violated, the losses are introduced due to refraction of light. This occurs when fiber is subjected to bending. Lower the radius of curvature more is loss. **<u>Loss Due to Attenuation:</u>** Attenuation is loss of power. During transit light pulse lose some of their photons, thus reducing their amplitude. Attenuation for a fiber is usually specified in decibels per kilometer. For commercially available fiber attenuation ranges from 1 db/km for premium small-core glass fibers to over 2000 db/km for a large core plastic fiber. Loss is by definition negative decibels. In common usage, discussion of loss omits the negative sign. The basic measurement for loss in a fiber is made by taking the logarithmic ratio of the input power (PI) To the output Power (PO). α (db)$=10 \log_{10} P_i/P_o$ Where, α is a loss in db/meter.
Procedure:	
For Loss due to Bending:	
1.	Connect the power supply to the board.
2.	<u>Make the following connections:</u> a). Function generator 1 KHz sine wave output to input socket of a emitter circuit via 4 mm lead. b). Connect 0.5 m optic fiber between emitter output and detector input. c). Connect detector output to amplifier input via 4 mm lead.
3	Switch on the power supply.
4.	Set the oscilloscope channel 1 to 5 V/div and adjust 4-6 div amplitude by using 1 probe with the help of variable pot in function generator block at input of emitter.
5.	Observe the output signal from detector (TP8) on CRO.
6.	Adjust the amplitude of the received signal as of transmitted one with the help of gain adjust potentiometer in AC amplifier block. Note this amplitude and name it.
7.	Wound the fiber optic cable on the mandrel and observe the corresponding AC amplifier output on CRO, it will be gradually reducing showing loss due to Bending.

For Loss due to Propagation OR Attenuation:

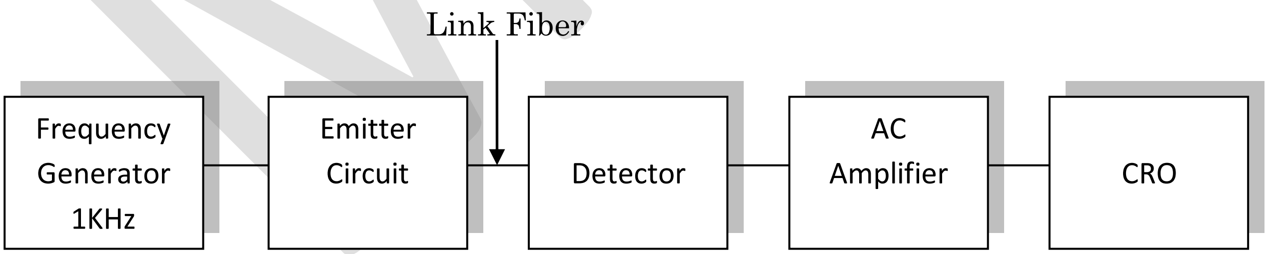
1st Six points will be the same for Bending loss and measurement of propagation or Attenuation loss in optical fiber.

7.	Now replace the previous fiber optic cable with 1 m cable without distributing any previous setting.
8.	Measure the amplitude at the receiver side again at output of amplifier socket (TP19). Note this value and name it V_2. Calculate the propagation (attenuation) loss with the help of following formula. $V_1/V_2= e^{-\alpha(L_1+L_2)}$ Where, α = loss in nepers/meter 1 nepers = 8.686 db L_1 = length of shorter cable (0.5m) L_2 = length of longer cable (1m)

Observation Table: For loss Due to Bending:

Without Bending (Amplitude in Volts)	With Bending (Amplitude in Volts)
0.7V	0.5V

Block Diagram: Fiber Optic Trainer



Observation Table: For loss Due to Attenuation:

Length of Fiber Cable	Amplitude (Amplitude in Volts)
0.5 m	V_1= 0.5
1.0 m	V_2=0.7

For Loss due to bending:

Result:	From above observation table, we can say that bending of fiber cable produces the loss in signal.

For loss due to Attenuation:

Result:	From above observation table, we can say that as the length of fiber increases, the loss of signal is also increases.

Viva Questions:

1.	Give the construction of Fiber cable.
2.	What is the total internal reflection?
3.	Define acceptance angle and numerical aperture.
4.	What is Kevlar?
5.	What are the types of fiber?
6.	Give the advantages of optical fiber cable over metal cable.
7.	What is fiber optic sensor?

Experiment No. 8(C)

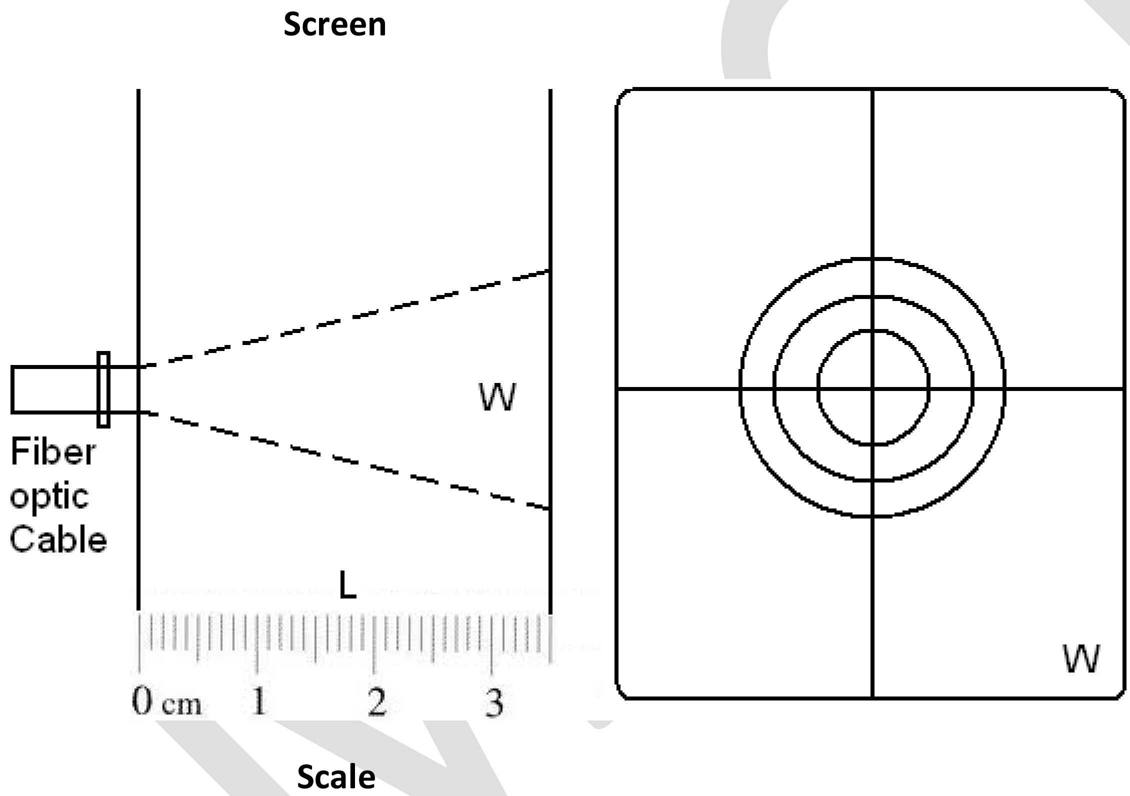
Objective:	Measurement of Numerical Aperture (NA) of optical fiber.
Equipments Needed:	Numerical Aperture measurement kit.
Theory:	Numerical aperture refers to the maximum angle at which the light incident on the fiber end is totally internally reflected and is transmitted properly along the fiber. The cone form by the rotation of this angle along the axis of the fiber is the cone of acceptance of the fiber. The light ray should strike the fiber end within its cone of acceptance else it is refracted out of fiber. **Consideration in NA measurement:** It is very important that the optical source should be properly aligned with the cable and the distance from the launched point and cable be properly selected to ensure that the maximum amount of optical power is transferred to the cable.
Procedure:	
1.	Connect the power supply to the board.
2.	Connect the frequency generator 1 KHz sine wave output to input of emitter circuit. Adjust its amplitude at $5V_{p\text{-}p}$.
3.	Connect one end of the fiber cable to the output socket of emitter circuit and the other end to the numerical aperture measurement kit. Hold the white screen facing the fiber such that its cut face is perpendicular to the axis of the fiber.
4.	Hold the white screen with 3 concentric circles (with various diameters) vertically at a suitable distance to make the red spot from the fiber coincide with their respective diameter of circles.
5.	Record the distance of the screen from the fiber end L and note the diameter W of the spot.
6.	Compute the Numerical Aperture from the formula given below. $N.A = \frac{W}{\sqrt{4L^2 + W^2}}$ $= \sin\theta \max$ (Acceptance angle)
7.	Vary the distance between in screen and fiber optic cable and make it coincide with one of the concentric circles. Note its distance.
8.	Tabulate the various distances and diameter of the circle made on the screen and computes the numerical aperture from the formula given above.

Inferences:	The numerical aperture recorded in the manufacturer data sheet is 0.5 typical. The variation in the observation is due to fiber being used.

Observation Table:

Sr. No.	**W (mm)**	**L (mm)**	$N.A = \frac{W}{\sqrt{4L^2 + W^2}}$	**θ = sin^{-1}(NA)**
1.	8	0.5cm=5mm	0.625	38.68
2.	13	1cm=10mm	0.5450	33.02
3.	17	2cm=20mm	0.3911	23.02

Figure:



Result:	Numerical Aperture (NA) of optical fiber is _____**31.57**________.