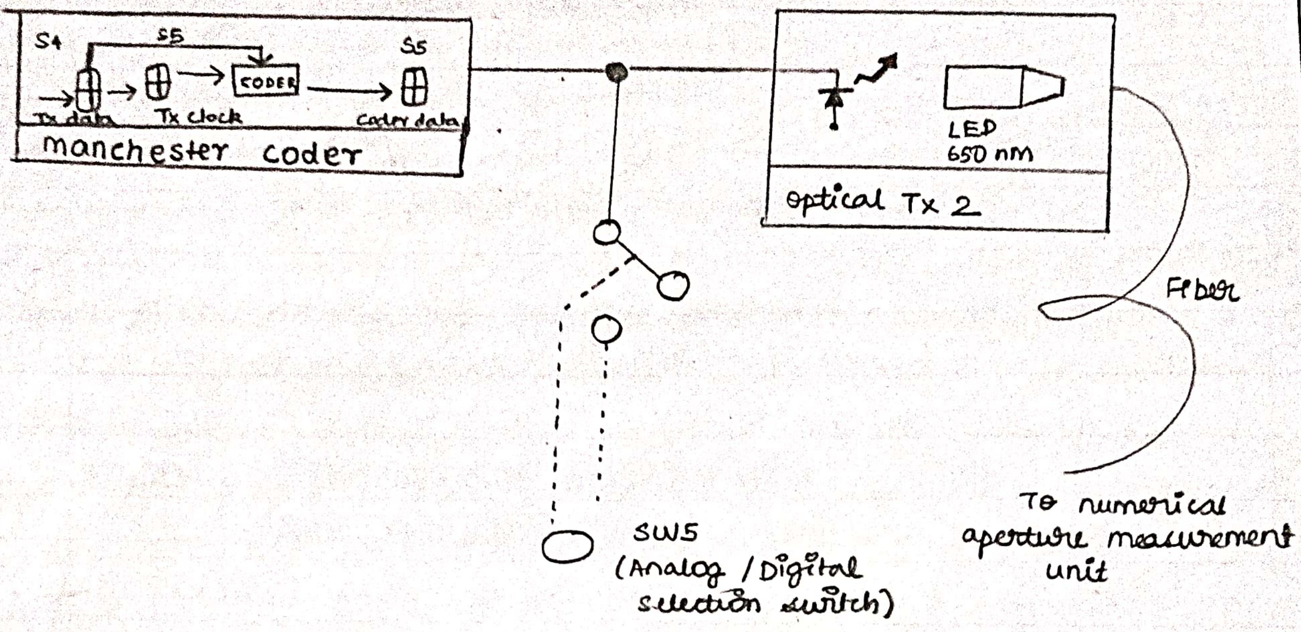

Fig 1 : Optical Numerical Aperture Kit

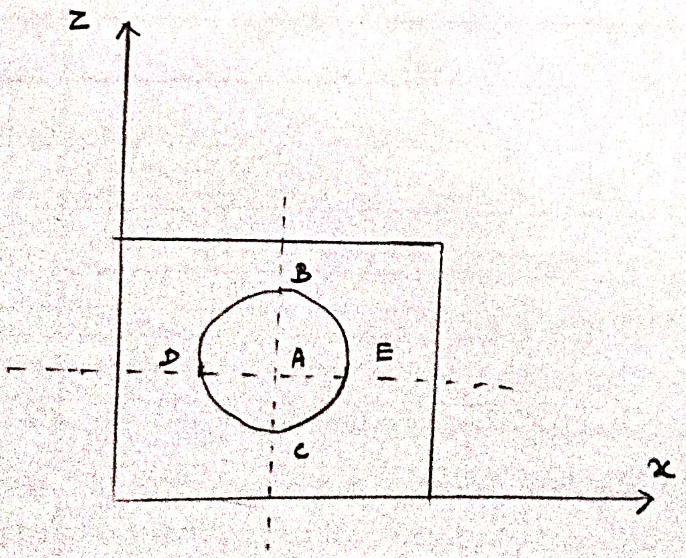

Fig : 3 Illuminated surface

Aim : To measure the numerical aperture of the plastic fiber provided with the kit using 660 nm wavelength LED.

Apparatus Required : power supply, Numerical Apertures measurement set up, 1 meter fiber cable, NA JIG/Ruler, power Meter.

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 light ray should strike the fiber end within its cone of acceptance, else it is refracted out of the fiber core.

Procedure : Refer to Fig 1 and make the following connection. Slightly unscrew the cap of LED SFH756V (650 nm). Do not remove the cap from the connector.

Now short the jumper as shown in the diagram. Connect the power cord to the kit and switch on the power supply.

Insert the other end of the numerical apperture measurement jig. Hold the white sheet facing the fibre. Adjust the fiber such that its surface is perpendicular to axis of the fiber.

TABULATION :

S NO	Diameter (cm) D	Radius (cm) r	Hieght (cm) h	$NA = r(h^2+r^2)^{1/2}$	$\theta = \sin^{-1}(NA)$
1.	0.6	0.5	0.275	0.3	0.675
2.	0.7	0.75	0.362	0.5	0.586
3.	0.85	0.8	0.412	0.8	0.458
4.	1.5	1.2	0.575	1	0.498
5.	4.5	1.3	0.7	1.2	0.503

Average : 0.544

calculation :

$$\theta = \sin^{-1}(NA)$$
$$= \sin^{-1}(0.544)$$
$$= 32.95^{\circ}$$

Numerical Aperture = 0.544

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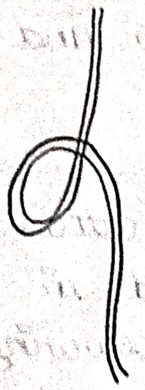
Keep the distance of about 10mm between the fiber tip and the screen. Gently tighten the screw and this fix the fiber in place.

Measure exactly the distance d and also vertical and horizontal diameter MR and PN as indicated in Fig 2. Mean radius is calculated using the following formula $r = (MR + PN)/4$.

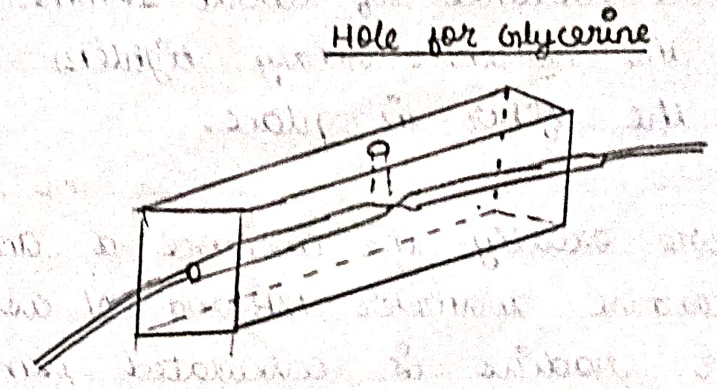
Find the Numerical aperture of the fiber.

Description	Maximum Marks	Marks Awarded
Aim / Procedure	2	2
Circuit / Program	2	2
Execution	2	2
Result	2	1
Viva	2	1
Total	10	8

Result : Hence, the numerical apperture of the plastic fiber provided with the kit using 660nm wavelength LED is obtained.

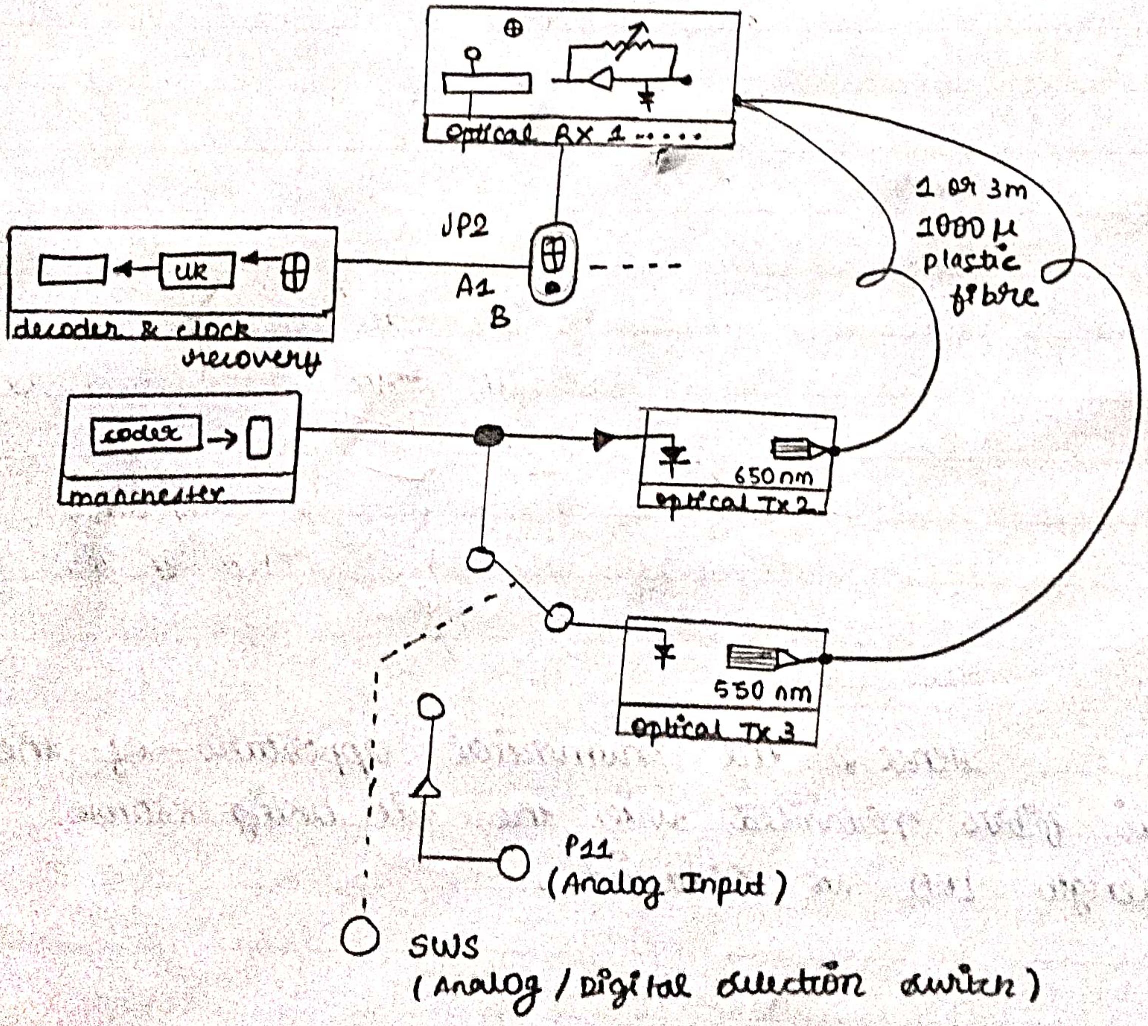


Bending the optical Fibre



Fibre

Fibre Alignment using Aligning unit



Expt. No. 2
Date 18/8/23

Aim : To measure the bending loss in plastic fiber for different wavelengths of radiation as 850 nm and 660 nm.

Apparatus Required : power supply, Optical Fiber Trainer (OFT) Kit, 20 MHz Dual Trace Oscilloscope, 1 & 3 Meter Fiber Cable.

Theory : Optical fiber are available in different variety of material. These materials are usually selected by taking into account their absorption characteristic for different wavelength of light. As light propogates from one end of fiber to another end, part of it is absorbed in the material exhibiting absorption loss.

In general terms it is known as a propogation loss. plastic fibers have higher loss of the order of 18 dB/Km. Whenever the condition for the angle of incidence of incident light is violated the losses are introduced due to the refraction of light.

This occurs when fiber is subjected to bending. Lower the radius of curvature more is loss. Another loss are due to the coupling of fiber at LED and photo detector ends.

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procedure : Identify the component on the OFT with the help of layout diagram. The block diagram of the circuit used in this experiment is shown in Fig.

set the switch S8W to the analog position. Ensure that the shorting plot of the jumper JP2 is shorting plugs from coded data shorting links.

Note the peak value of the signal recieved at P31 and designate it as V1. Replace the 1 m fiber by the 3m fiber between LED1 and PD1. Again, note the peak value of the reciever signal and designate it as V3, If alpha is attenuated in the fiber and l_1 and l_3 are exact length of 1 m and 3 m fibers in meter, respectively

$$\frac{P_3}{P_1} = \frac{V_3}{V_1} = exp[-\alpha[l_3 - l_1]]$$

setup the 850 nm analog link using the 1m fibre. Drive a 1V p-p sinusoidal signal of 10 KHZ with zero d.c. at P11 and observe the recived signal at P31 on the oscilloscope. Keep reducing the diameter of the loop to about 2 cm and plot the amplitude of the recieved signal versus the diameter of the loop.

Observe that the recieved signal at P31 varies as the free ends of the fiberes are brought closer and moved apart. using the attenuation constant value obtained in step 4.

TABULATION :

S.NO	Bend diameter (cm)	output power (dBm)	output voltage (V)
1.	5	-28.9	4.04×10^{-3}
2.	4	-24.1	3.89×10^{-3}
3.	3	-24.2	3.80×10^{-3}
4.	2	-24.6	3.46×10^{-3}
5.	1	-26.4	2.29×10^{-3}

connection loss :

$P(1+2) = -44.7$ dm $= 3.38 \times 10^{-5}$ mW

$P_3 = -34.7$ dBm $= 3.38 \times 10^{-4}$ mW

$P_{loss} = P_3 - (P(1+2)) = -3.042$ mW

Attenuation : $P_1 = -30.2$ dBm $= 9.54 \times 10^{-4}$ mW

$P_3 = -34.7$ dBm $= 3.38 \times 10^{-4}$ mW

$$\alpha = \frac{1}{2} \ln\left(\frac{P1}{P2}\right)$$

$$= \frac{1}{2} \ln\left[\frac{9.54 \times 10^{-2}}{3.38 \times 10^{-4}}\right]$$

$$\alpha_p = 0.518 \ Np/m$$

$$\alpha = 4.343 \ \alpha_p \ dB/m$$

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$$\eta = -10\log\left[\frac{V_4}{V_1}\right] - \alpha(l_3 + l_1)$$

compute the coupling loss in the presence of index matching fluid like glycerine. why does the index matching fluid affects the coupling loss? Now try aligning the two fibers without using the Fiber alignment unit.

Calculation :

Attenuation loss : $\frac{P_3}{P_1} = \frac{V_3}{V_1} = \exp[-\alpha[l_3 - l_1]]$

Compute α in dB/km = 4.343α, where α is in nepers/m

L_1 = length of shorter fiber

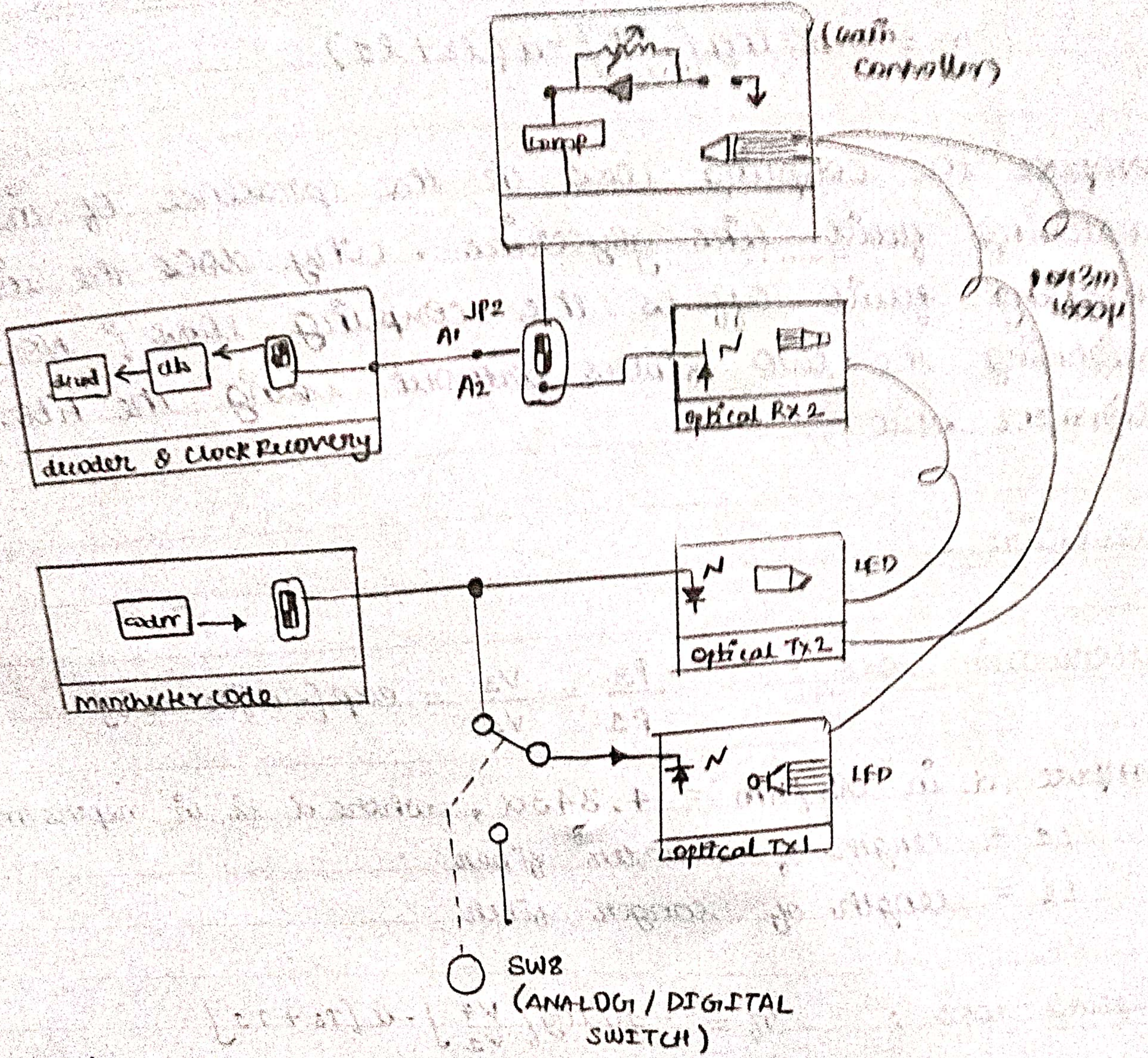
L_3 = length of longer fiber

coupling loss : $\eta = -10\log\left[\frac{V_4}{V_1}\right] - \alpha[I_3 + I_1]$

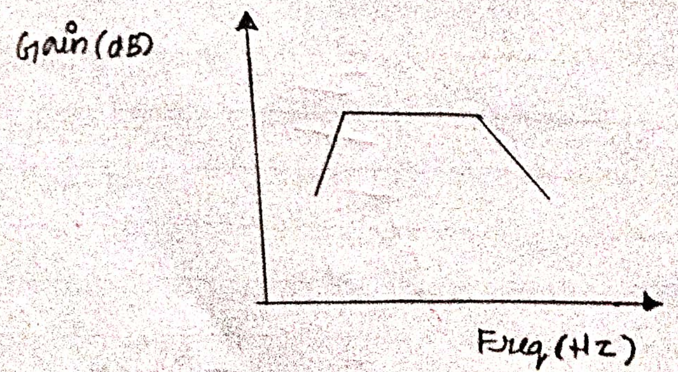
Description	Maximum Marks	Marks Awarded
Aim / Procedure	2	2
Circuit / Program	2	2
Execution	2	2
Result	2	1
Viva	2	1
Total	10	8

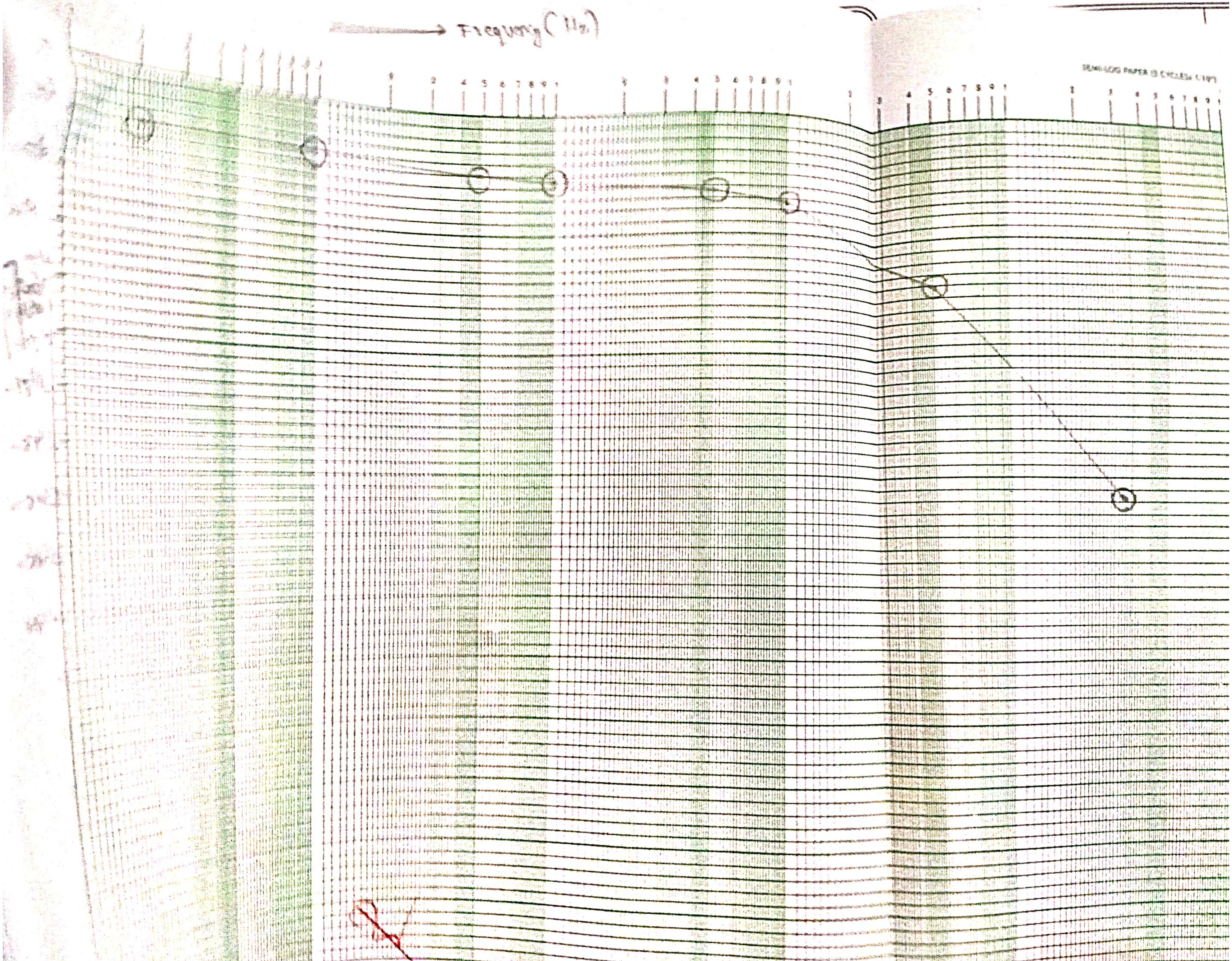
Result : Hence, the bending loss in plastic fiber for differentially wavelength is obtained.

ock Diagram :



Model Graph :




Frequency (Hz)

Expt. No. 2
Date 25/8/23

Aim : To set up an 850 nm fiber optic digital and analog link and to plot its frequency response.

Apparatus Required : power supply, Optical Fiber Trainer, 20MHZ Dual channel Oscilloscope, 1 meter cable.

Theory : Fiber optic links can be used for the OFT with the help of layout diagram. The block diagram of the circuit used in this experiment.

Set the switch SS to analog position. switch power on. The power on switch is located at the top right-hand corner.

Feed a 1V p-p sinusoidal signal at 1KHZ from functional generator, to the analog In P11. Connect one end of the 1m fiber to LED source LED1 in the optical transmitter block.

Vary the input signal level driving the LED and observe the recieved signal at the PIN detector. plot the recieved signal with respect to input signal.

Setting up fiber optic digital link :

Identify the components on the OFT with the help of layout diagram. The block diagram of the circuit.

Tabulation : Digital Link

Input signal	Output signal
10101100	10101100
10010010	10010010
11010011	11010011

Tabulation : Analog Link

Frequency	Output Voltage (v)	Gain = $20\log(V_0/V_i)$
100 Hz	348	-3.147
200	346	-3.197
1K	348	-3.147
5K	346	-3.197
10 K	338	-3.401
50 K	328	-3.661
100K	297	-4.264
500 K	101	-13.892
1M	30.6	-24.264
3M	22.5	-26.935

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Set the switch SW5 to digital position. Connect a 1m optical fibre between LED1 and the PIN diode PD1. Set the binary input data by using SPDT switches and verify the output LEDs.

Description	Maximum Marks	Marks Awarded
Aim / Procedure	2	2
Circuit / Program	2	2
Execution	2	✓
Result	2	1
Viva	2	1
Total	10	8

Result : Hence, 850 nm fiber optic digital and analog link and to plot its frequency response is obtained.

LED Module :

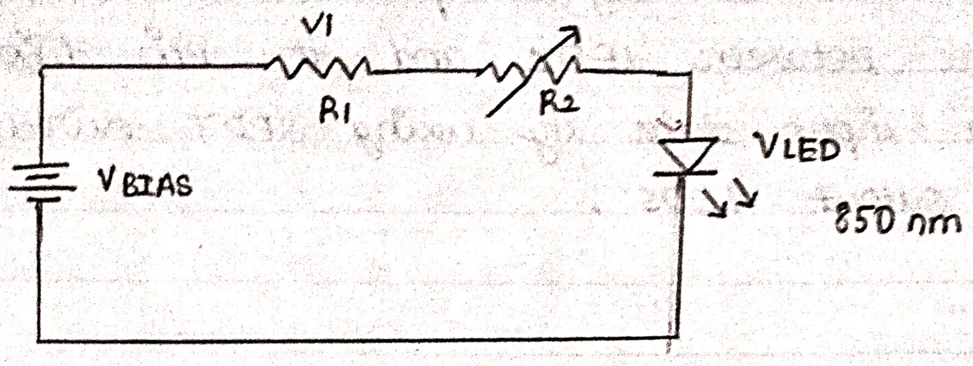
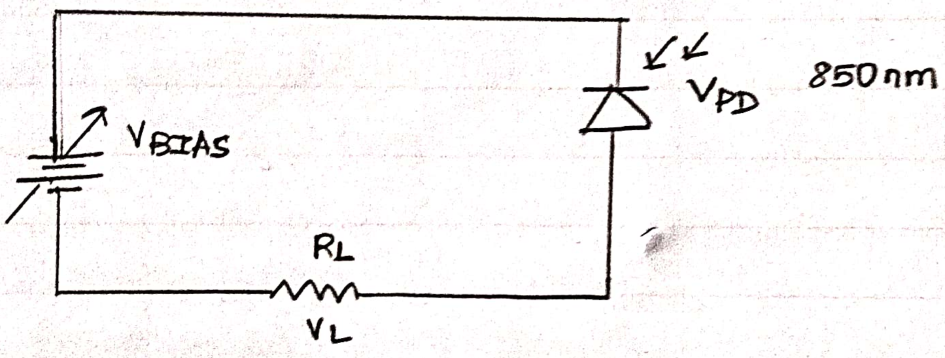


Photo diode Module :



Aim : To determine the characteristic of an LED and PIN photo diode.

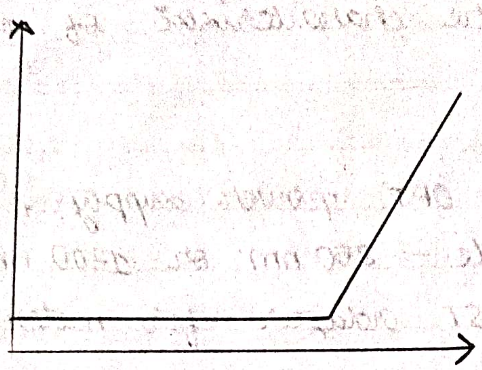
Apparatus Required : OFT power supply, A digital multimeter, LED module - 850 nm or 1300 nm, Fibre optic power supply, ST adapter for meter, PD module, 1m ST-ST patch cord.

Theory : LED is the vital part in fiber optic communication link. It forms the Electrical - Optical section of the transmitter in any link. The module needs an external DC power supply to operate. The LED module is provided with appropriate monitoring posts for taking the necessary measurement.

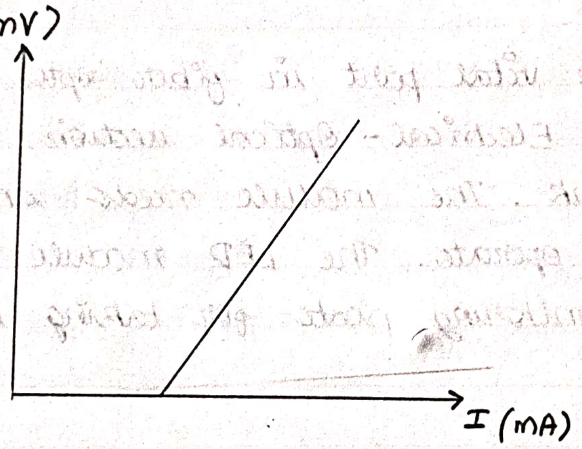
LED Module setup : The LED module mainly consist of a fiber optic LED for which the characteristic will be studied, a multi-turn potentiometer for varying the current through LED, a high precision resistor for calculating the current.

Calculation : Conversion Efficiency $\eta = \frac{P_o}{I_F}$, where
P_o - Output power
I_F - Forward current.

Model Graph :



(V–I characteristic)



(P–I characteristic)

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procedure :

connect the Optical Fibre Trainer power supply properly to the module using the DIN - DIN cable provided with the power supply. Measure the voltage V_1 across the resistor R_1 and calculate the current through the LED I_F which is given as $I_F = V_1/100$ for 850 nm PF.

Mount the bare fiber adaptor - plastic over the PD. carefully hold the LED source very close to the photo-detector window perpendicular to it to couple all the optical power from the LED to the power meter.

Repeat step 4 and note down several reading till the potentiometer reaches it maximum position and plot the graph for V_{LED} vs I_F and I_F vs P_o. Calculate the E-O conversion efficiency 'η' of the LED from the plotted graph I_F vs P_o, which is given by

$$\eta = P_o / I_F$$

put 10K resistor across V_2 in the PD module and adjust the potentiometer and fix the bias voltage at 10V. Connect the ST connector end of the patch cord and vary the optical power and Tabulate the reading. plot the graph P_o vs I_R and $I_R = V_1/10 \times 10^3$.

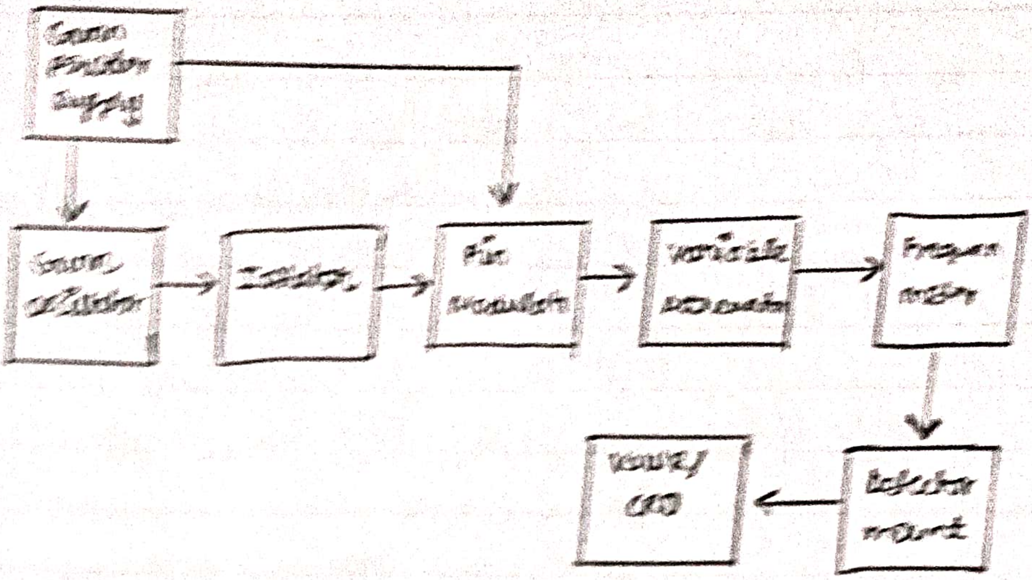
Tabulation :

No	V_1 (mV)	I_F (mA)	V_{LED} (mV)	P (dBm)	P_o (mW)	V_L (V)	I_R (mA)
1.	247	1.89	1.2	-34.3	3.71×10^{-4}	0.3	0.03
2.	275	1.52	1.21	-33.6	4.36×10^{-4}	0.4	0.04
3.	379	2.10	1.22	-31.1	7.58×10^{-4}	0.6	0.06
4.	495	2.75	1.236	-30.5	8.9×10^{-4}	0.7	0.07
5.	580	3.22	1.234	-30.3	9.3×10^{-4}	0.9	0.09
6.	619	3.43	1.234	-30.5	8.9×10^{-4}	0.3	0.03
7.	682	3.78	1.243	-28.9	1.02×10^{-3}	0.7	0.07
8.	843	4.68	1.253	-27.9	1.14×10^{-3}	0.9	0.08
9.	887	4.92	1.255	-28.5	1.41×10^{-3}	1.1	0.11
10.	927	5.15	1.261	-27.9	1.62×10^{-3}	0.7	0.07
11.	1052	5.84	1.280	-26.4	2.29×10^{-3}	2.8	0.28
12.	1546	8.58	1.280	-25.4	2.75×10^{-3}	3	0.8
13.	1962	10.9	1.293	-25.6	2.95×10^{-3}	3.4	0.34
14.	2259	12.5	1.301	-25.3	3.71×10^{-3}	2.9	0.29

Description	Maximum Marks	Marks Awarded
Aim / Procedure	2	2
Circuit / Program	2	2
Execution	2	2
Result	2	1
Viva	2	1
Total	10	8

Result : Hence, the character of an LED and PIN photo diode is determined.

Block Diagram :



Aim : To determine the various characteristic of the Gunn Diode.

Apparatus Required : Gunn power supply, Gunn oscillator, Pin modulator, Isolator, Frequency meter, slotted section with probe, Detector mount, VSWR meter, power meter.

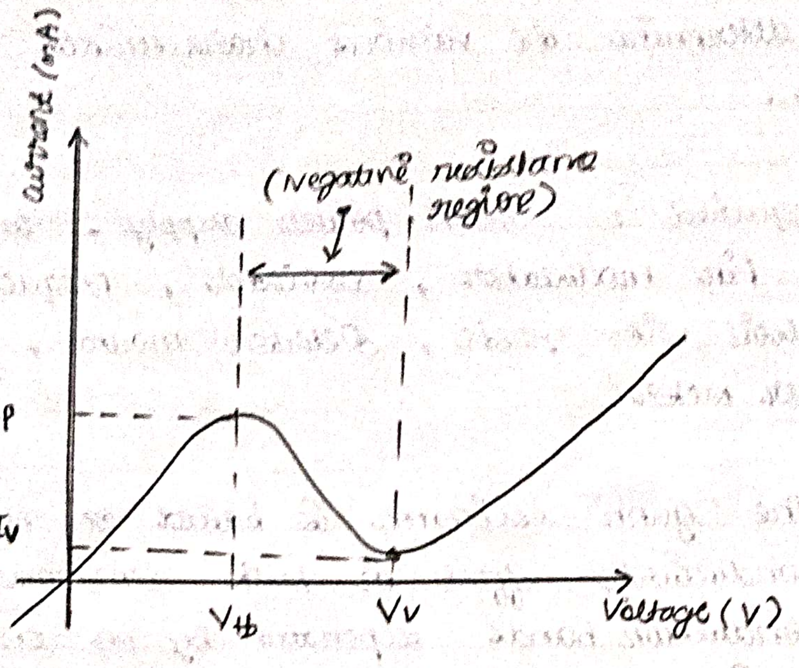
Theory : The gunn oscillator is based on negative differential conductivity effect in bulk semiconductor which has two conduction bands seperated by an energy gap. The time required for domain to travel from cathode to anode give oscillation frequency.

Threshold voltage : It is defined as the voltage at which the current starts decreasing.
Valley voltage : It is the voltage at which the negative resistance region ends.
Valley current : It is the current corresponding to the valley voltage.
Negative resistance : It is the reciprocal of the slope of the negative resistance region of the Gunn diode.

Procedure :

For determining the parameters :

Model Graph :



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Set up the connection as shown in the block diagram. Switch on the Gunn power supply and Gunn bias voltage. Read the corresponding current in the panel meter of the power supply by switching the selector knob from voltage mode to current mode.

For determining the Frequency vs Voltage:

Switch ON the Gunn power supply and Gunn bias supply. By slowly increasing the bias voltage select a voltage which is just above the threshold voltage. Note down the corresponding Gunn bias voltage. Adjust the slotted section to obtain the maximum output from the oscillator. Rotate the frequency meter and when a dip is obtained in CRO note down the corresponding frequency. Repeat this to the maximum allowable Gunn bias voltage.

Tabulation :

S.NO	Gunn Bias Voltage	Gunn Bias Current	S.NO	Gunn Bias Voltage	Gunn bias current
1.	0.54	0.059	13.	5.5	0.167
2.	1.16	0.118	14.	6.03	0.161
3.	1.54	0.148	15.	6.59	0.155
4.	2.07	0.178	16.	7.09	0.150
5.	2.35	0.190	17.	7.56	0.147
6.	2.53	0.196	18.	3.13	0.148
7.	3.07	0.206	19.	8.57	0.140
8.	3.25	0.206			
9.	3.6	0.208			
10.	4.12	0.202			
11.	4.5	0.189			
12.	5.01	1.77			