MICROWAVE & OPTICAL COMMUNICATION LAB

17ECCC91

B.E/B.TECH-ECE

PROGRAM, BRANCH	B.E/B.Tech -ECE
LAB COURSE NAME	MICROWAVE & OPTICAL COMMUNICATION LAB
LAB CODE	17ECE91
ACADEMIC YEAR	2020-2021 (EVEN SEM)

HOD/ ECE

Experiment No: 1 **Date:**

CHARACTERISTICS OF GUNN DIODE OSCILLATOR

Aim:

To determine the V-I Characteristics of a GUNN Diode oscillator.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1	Gunn Power Supply	1
2	Gunn Oscillator	1
3	Variable Attenuator	1
4	Frequency Meter	1
5	Slotted Section with Tunable Probe	1
6	Detector Mount	1
7	Isolator	1

Theory:

The Gunn Oscillator is based on negative differential conductivity effect in bulk semiconductors which has two conduction bands separated by an energy gap (greater than the terminal energies). A disturbance at the cathode gives rise to high field region which travels towards the anode. When this field domain reaches the anode, it disappears and another domain is formed at the cathode and starts moving towards anode and so on. The time required for domain to travel from cathode to anode (transit time) gives oscillation frequency. In a Gunn Oscillator, the Gunn diode is placed in a resonant cavity. The Oscillation frequency is determined by cavity dimensions._Although Gunn Oscillator can be amplitude modulated with the bias voltage. We have used a PIN modulator for square wave modulation of the signal coming from Gunn diode. A measure of the square wave modulation capability is the Modulation depth. That is the output ratio between 'ON' and 'OFF'.

Procedure:

1. Set up the equipments as shown in figure.
2. Set the Variable Attenuator at minimum position.
3. Keep the Control knobs of Gunn Power supply as below:

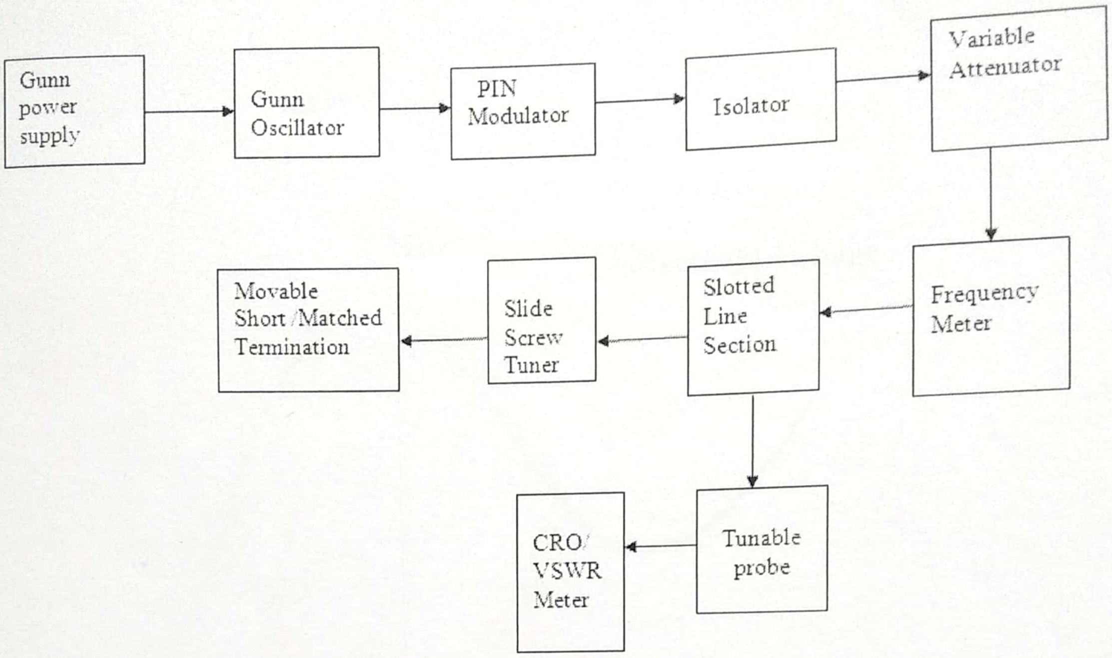
Meter Switch	- OFF
Gunn Bias Knob	- Fully anticlockwise
PIN Bias Knob	- Fully anticlockwise
PIN Mode Frequency	- Any position.

4. Set the Micrometer of Gunn Oscillator for required frequency of operation.
5. Switch ON the Gunn Power Supply and Cooling fan.
6. Measure the Gunn diode current corresponding to the various Gunn bias voltages through the digital panel meter and meter switch. Do not exceed the bias voltage above 8 volts.
7. Plot the Voltage and Current readings on the Graph as shown inn figure.
8. Measure the Threshold voltage which corresponds to maximum current.

Note:

Do not keep Gunn bias knob position at threshold position for more than 10-15 seconds. Readings should be obtained as fast as possible. Otherwise due to excessive heating, Gunn diode may burn.

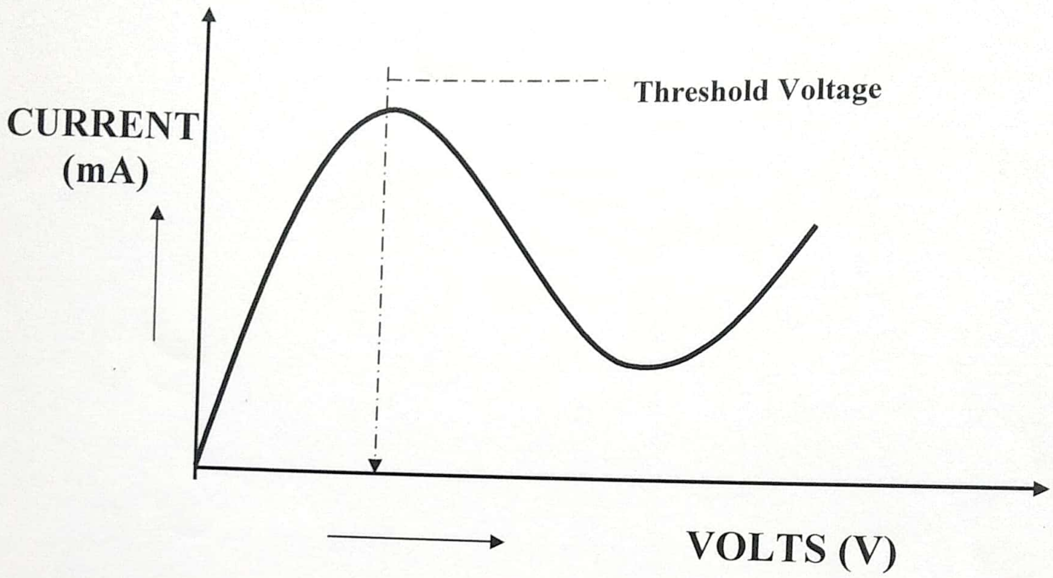
Block Diagram:



Tabulation:

Sl.No.	Gunn Bias Voltage V (Volts)	Gunn Oscillator Current I (mA)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Model graph:



Result:

Thus the V-I Characteristics of a Gunn Diode Oscillator is determined.

Experiment No: 2 **Date:**

CHARACTERISTICS OF REFLEX KLYSTRON

Aim:

To study the characteristics of a Reflex Klystron tube.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1	Klystron power supply	1
2	Klystron mount	1
3	Klystron tube	1
4	Frequency meter	1
5	Variable attenuator	1
6	Slotted section with probe carriage	1
7	Oscilloscope	1

Theory:

A Reflex klystron uses only cavity as both buncher and catcher. The electron beam which goes through the cavity is velocity modulated and is reflected and passes back through the cavity. Outer conductor is at ground potential. The electron beam from the gun goes through the cavity and bunched and then electrons do not actually reach the repeller but are reflected sooner by the negative voltage. These electrons then enter the cavity which now acts as a catcher for these electrons. The move negatives the voltage sooner the electron turn. For maximum power output these should complete bunching of the reflected beam at the cathode, varying the repeller voltage varies frequency, over a narrow range as volt as power output. A small frequency change can be obtained by adjusting the reflector voltage. This is called electronic range.

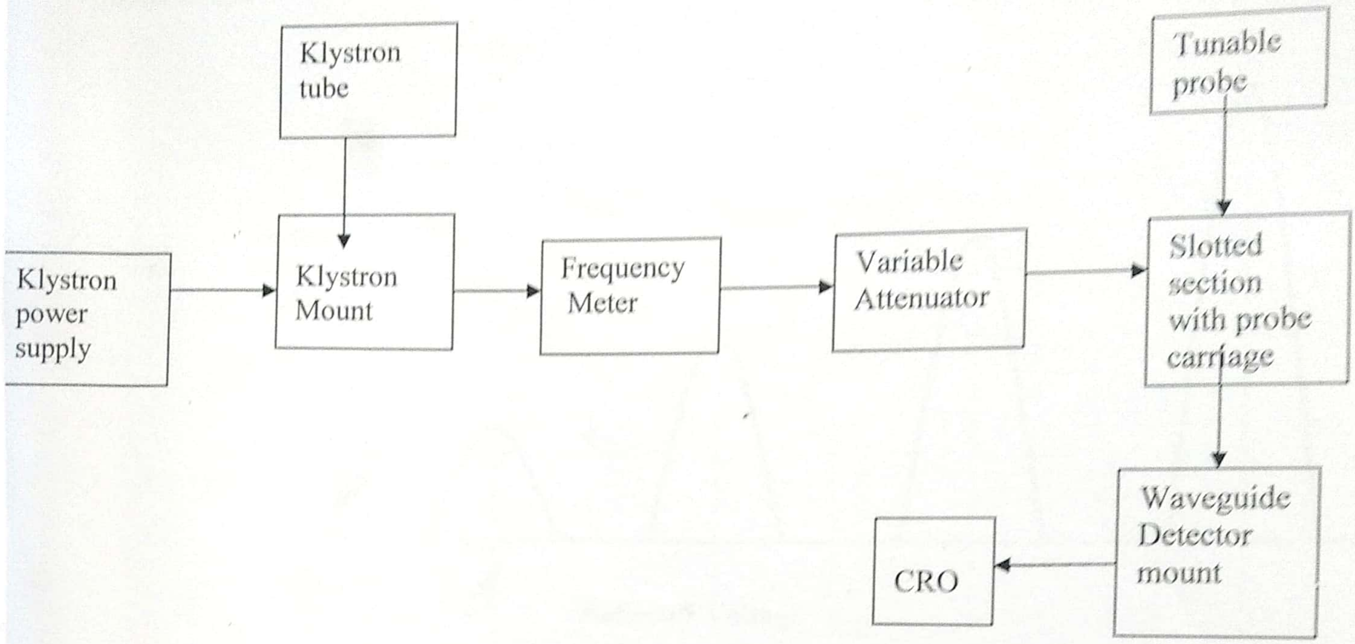
Procedure:

1. Connect the equipment and component as shown in block diagram.
2. Set micrometer of variable attenuator around some position.
3. Set mode selection switch to amplitude modulation position beam voltage Control fully anti-clockwise direction. Reflector voltage control knob to the max, Clockwise direction.
4. Switch ON the klystron power supply, CRO and cooling fan.
5. Switch ON the beam Voltage and rotate beam voltage knob clockwise up to 300V deflection in meter.
6. Keep the AM- mode amplitude knob, AM frequency knob at the midpoint.
7. Rotate the repeller Voltage knob to get output in CRO.
8. Rotate the AM-mode amplitude knob to get the maximum output in CRO.
9. Maximize the output with frequency control knob at AM- mode.
10. The output can also be reduced by variable attenuator for setting the output for any particular position.

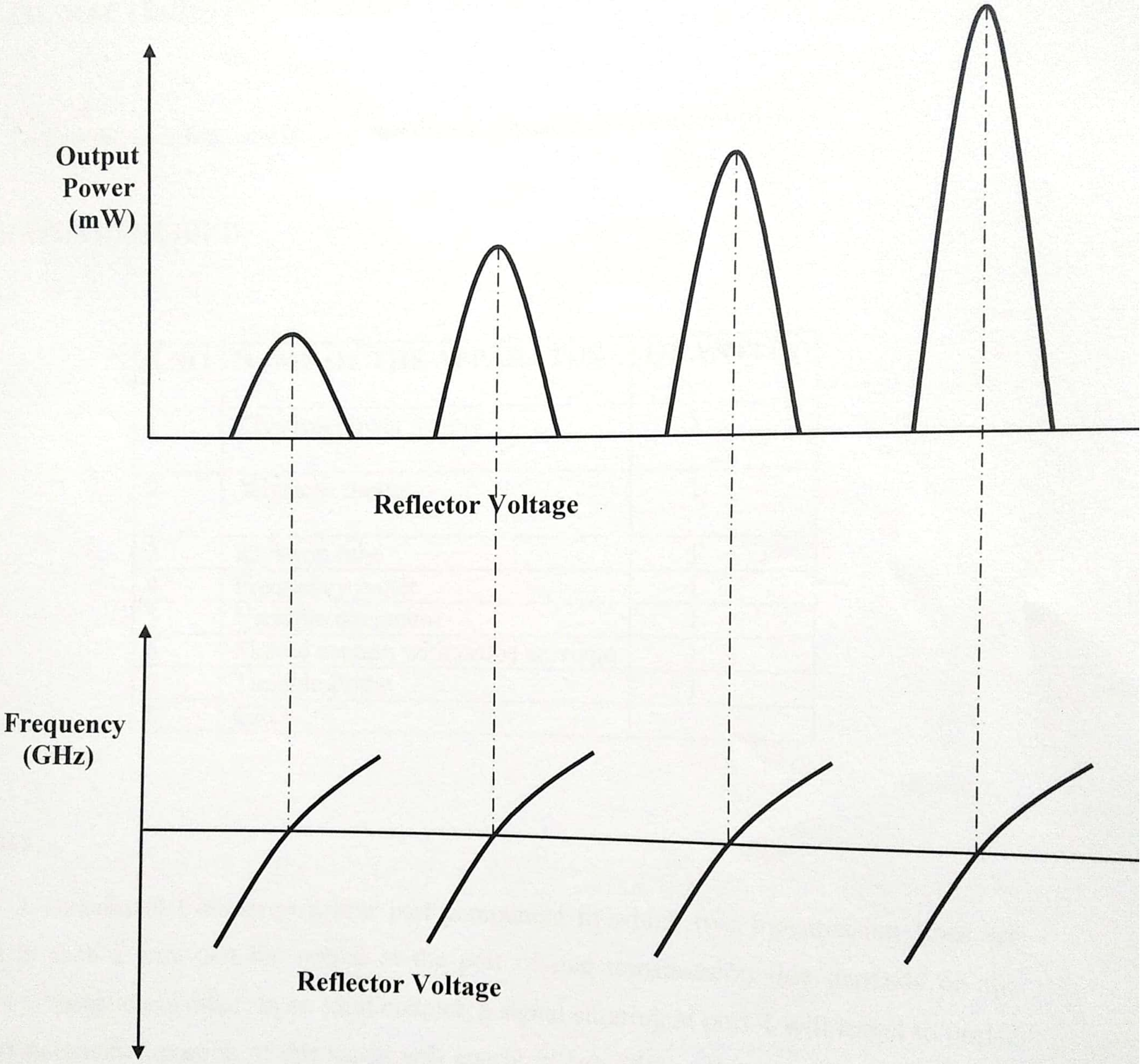
Tabulation:

Sl.No.	Repeller Voltage	Output Voltage
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Block Diagram:



Model Graph:



Result:

Thus the characteristics of a klystron tube were studied.

Experiment No: 3

Date:

CHARACTERISTICS OF DIRECTIONAL COUPLER

AIM:

To find the coupling co-efficient and directivity of directional coupler.

APPARATUS REQUIRED:

S.NO	NAME OF THE APPARATUS	QUANTITY
1	Klystron power supply	1
2	Klystron mount	1
3	Klystron tube	1
4	Frequency meter	1
5	Variable attenuator	1
6	Slotted section with probe carriage	1
7	Tunable Probe	1
8	CRO	

THEORY:

A Directional Coupler is a four part component in which two transmission lines are coupled in such a way that the output at the port of one transmission line depends on the direction propagation in other. In an ideal coupler, a signal entering at port-1 will travel to port-2 and a pre-determined portion of this signal will appear at one of the other two ports. There will be zero output at port-4.f this main signal travels in this reverse direction, from port-2 to port-1, a small coupled signal will appear at the port which is isolated in the first case. When a signal travels from port-1 to port-2, the coupled signal travels and appears at either port-3 or port-4 depending on the coupling mechanism used.

The coupling co-efficient of a directional coupler at a particular point is the ratio of the input power to the coupled output power, expressed in dB. A measure of performance of the DC is its directivity. This is defined as the ratio expressed in dB of the output of coupling arm to the unwanted signal in the fourth arm which is 1%.The directivity can be more or less than the coupling coefficient.

Coupling co-efficient = 20 log Vmax / Vmin.

Directivity = Y – X

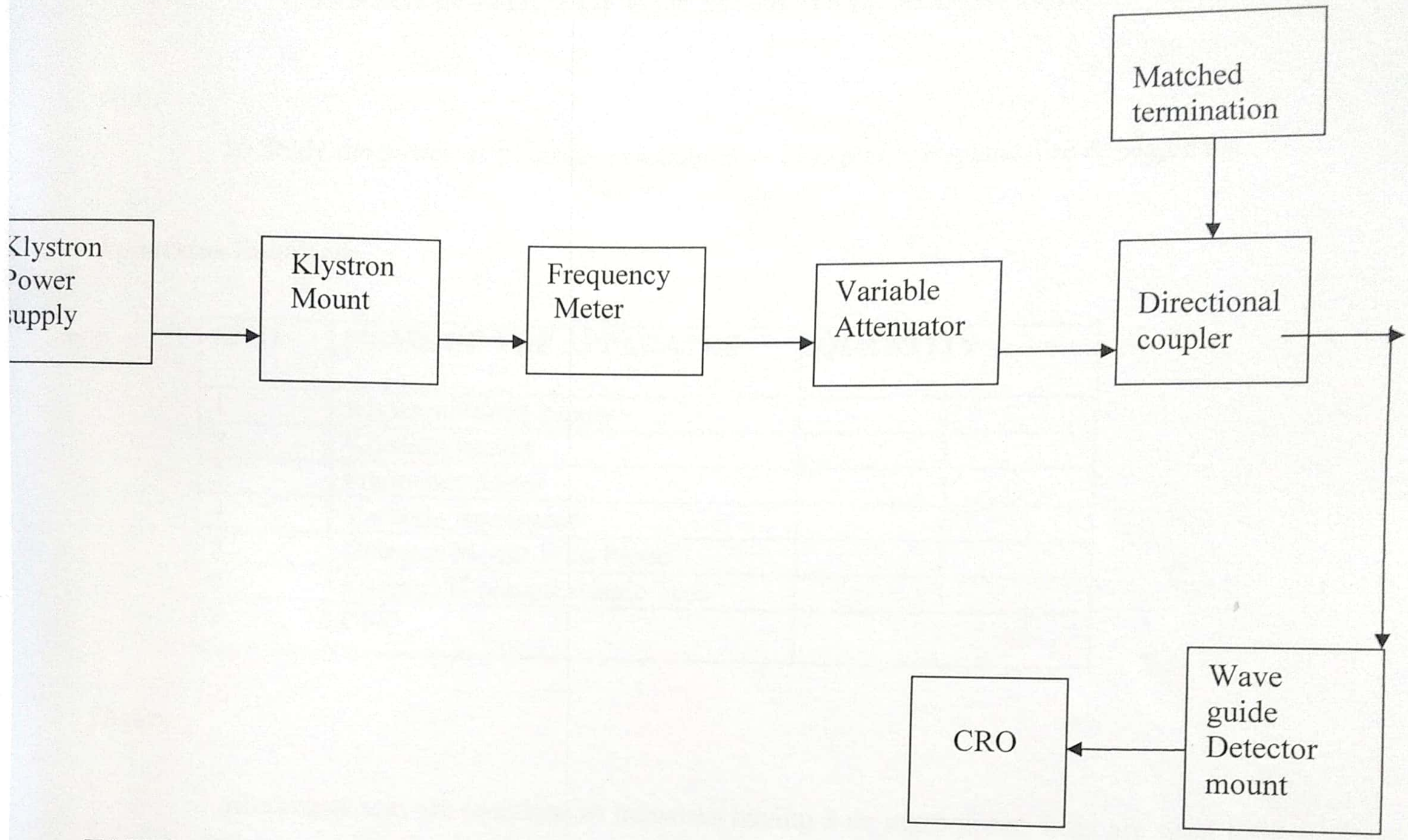
Y → Backward Co-efficient

X → Forward Co-efficient

PROCEDURE:

1. Set up the experiment as shown.
2. Energize the micro wave source for particular operation frequency.
3. Remove the multi hole directional coupler and connect with the detector mount to CRO.
4. Insert the directional coupler as shown with detector to port-B and matched termination at port-A.
5. Note down the reading on the CRO. Now interchange detector to port-A and matched termination to port-B.
6. Now connect the directional coupler in reverse direction, port-B to slotted section with probe carriage and port-A to detector with matched termination.
7. Using the reading on CRO, interchange the detector to port-B and matched termination to port-A and measure reading in CRO.
8. Using formula, calculate coupling co-efficient and directivity of the directional coupler.

BLOCK DIAGRAM:



TABULATION:

Path	Inputs	Outputs	Obtained Value
Forward	Port A	Port B Port D	
Backward	Port B	Port A Port D	

Result:
Thus the directional coupler is studied.

Experiment No: 4 **Date:**

CHARACTERISTICS OF E / H PLANE TEE, MAGIC TEE

Aim:

To Study the power distribution characteristics in E-plane, H-plane Tee & Magic tee.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Klystron Power supply	1
2.	Klystron Mount	1
3.	Frequency Meter	1
4.	Variable Attenuator	1
5.	Detector Mount With Probe	1
6.	E-plane, H-plane& Magic Tees	1
7.	CRO	1

Theory:

Microwave tees are junctions or networks having 3 or more ports. Tees are used to connect a section of the waveguide inn series or parallel with the main waveguide.
Various types of Tee junctions are

(i) E-plane Tee
(ii) H-plane Tee
(iii) Magic Tee

E-plane Tee

Here a rectangular slot is cut along the broader dimension of the waveguide & side arm is attached. Ports 1& 2 are called collinear arms & port3 is called E-arm. When the input is fed at port3, the output at port 1&2 will be out of phase by 180°. E-plane tee is a voltage or series junction.

H- plane Tee

Here a rectangular slot is cut along the width of the main waveguide & sidearm is attached. Ports 1& 2 are called collinear arms & port3 is called H-arm. H-plane tee is a current junction. When the input is fed at port3, the output at ports1 & 2 are in phase.

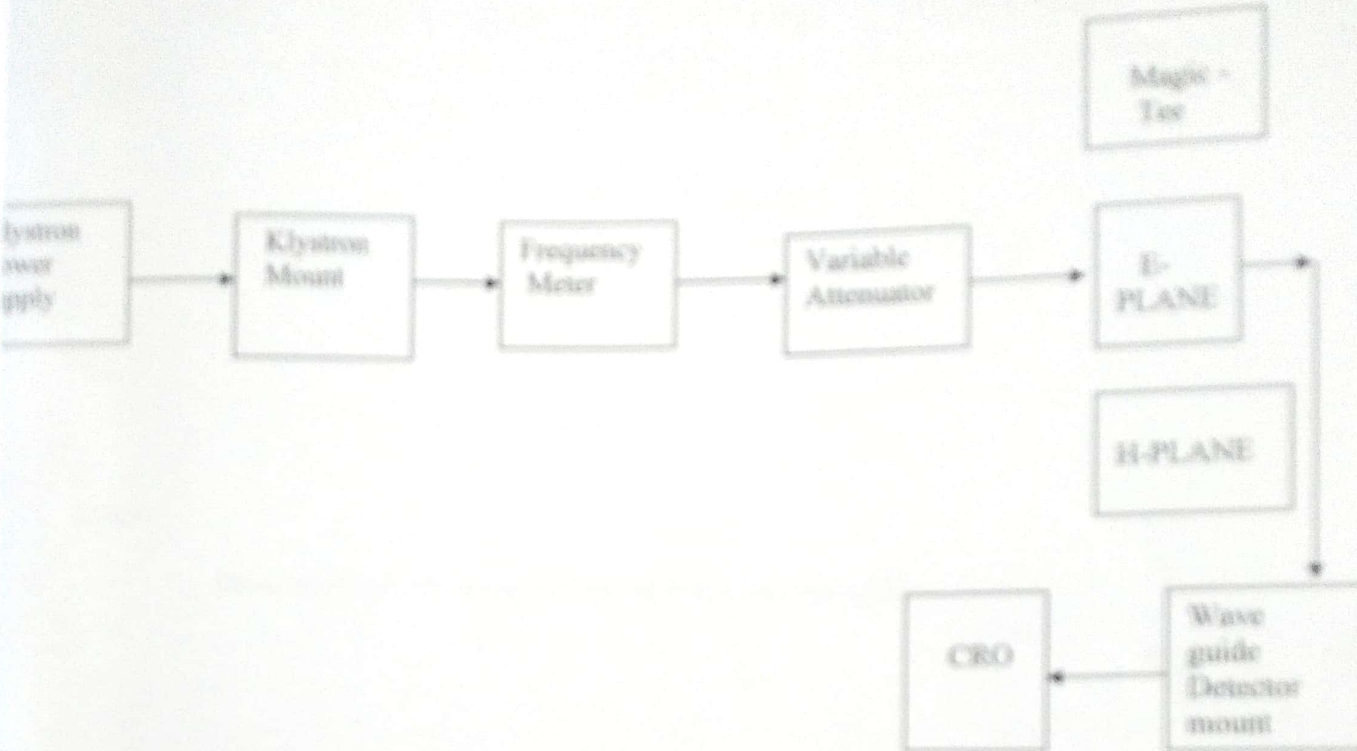
Magic-Tee

Here a rectangular slot is cut both along the width & breadth of the Waveguide & side arms are attached. Port3 is H- arm & port 4 is E-arm. It combines both the properties of E-plane & H-plane tees.

Procedure:

1. Make the connections as per the block diagram
2. Observe the outputs by placing E-plane, H-plane& Magic tees one after the other.
3. Tabulate the readings.

Block Diagram:



Tabulation:

E-PLANE TEE:

INPUT AT PORT C	OUTPUT AT PORT A		OUTPUT AT PORT B	
	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL

H-PLANE TEE:

INPUT AT PORT C	OUTPUT AT PORT A		OUTPUT AT PORT B	
	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL

MAGIC TEE:

INPUT PORT	INPUT VALUE	OUTPUT PORT	OUTPUT VALUE
PORT C		PORT D	
PORT D		PORT C	

Result:

The operations of E-plane, H-plane & Magic tees are verified.

Experiment No: 5 **Date:**

HORN ANTENNA – GAIN AND DIRECTIONAL CHARACTERISTICS

Aim:

To study the characteristics of a Horn Antenna Gain and Directional characteristics.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1	Klystron power supply	1
2	Klystron mount	1
3	Klystron tube	1
4	Frequency meter	1
5	Variable attenuator	1
6	Slotted section with probe carriage	1
7	Tunable Probe	1
8	Transmitting and Receiving antenna	1
9	Slide Screw tuner	1
10	Wave guide mount with crystal	1
11	CRO	1

Theory:

An Antenna transfers energy between a transmitter and a receiver through the medium. Small distances and low frequencies tend to favor transmission lines and wave guides, while large distances and high frequencies tend to favor antenna.

If a transmission line propagating energy is left open at one end, there will be radiation from this end. The mismatch will be improved, if the open wave guide is given a horn shape. This will also result in a more concentrated radiation because of the larger radiation area or aperture.

A point source, i.e. an isotropic radiator will radiate power evenly in to space. However, a real antenna favors certain direction rather than others. Power intensity Vs the antenna angle at a constant distance from the radiating antenna.

For practical reasons, it is presented two dimensionally and consists of many lobes.

Gain

Gain G is the power intensity at the maximum of the main lobe compared to the power intensity achieved from an imaginary isotropic antenna with the same power fed to the antennas. The field of an antenna consists of two parts, the induction field and the radiating field. Normally antenna measurements take place in the far field.

Directivity

The directivity D of an antenna is defined as the ratio of the maximum power density at a given distance to the average power density at that distance.

$$D = Pmax / Pavg$$

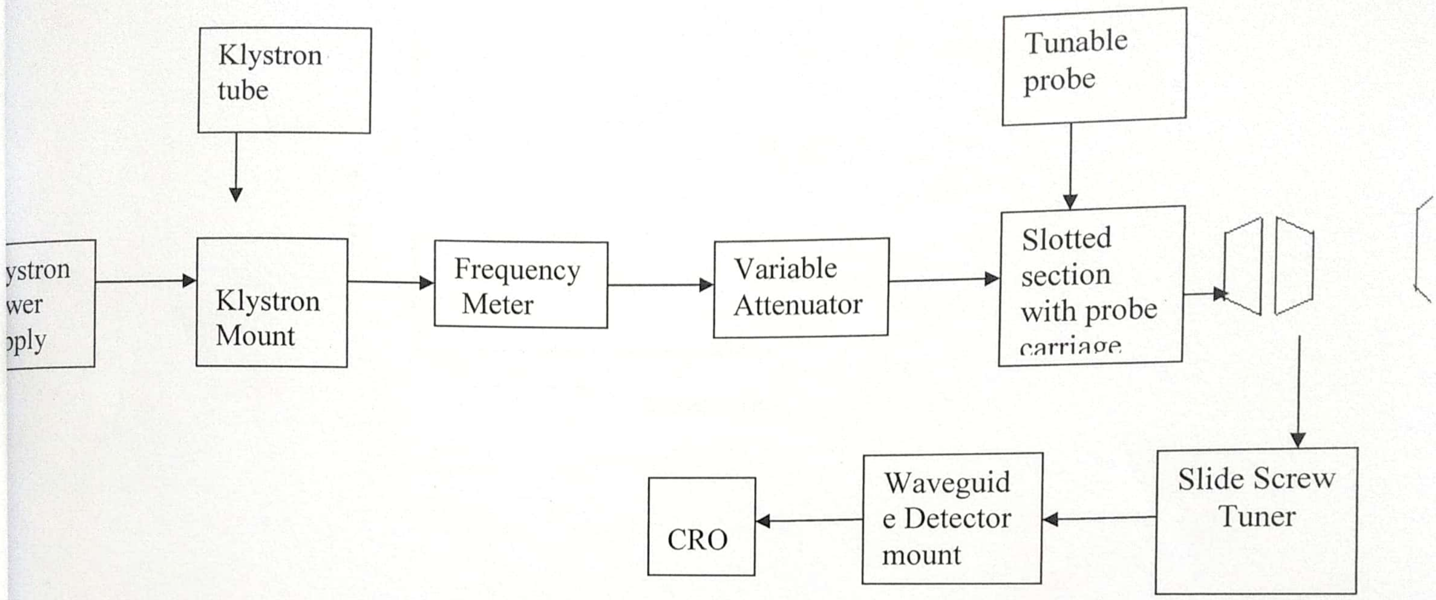
The directivity can also be expressed as $D = 4\pi / \Omega$

Where Ω is the beam solid angle. The greater the value of 0, the better an antenna conventual's energy.

Procedure:

1. Set up the equipments and component as shown in block diagram.
2. Keep the axis of the two antennas in the same line. Energize the Kps maximum output at desired frequency of square wave modulation by tuning the square wave amplitude and frequency of modulating signal of Kps.
3. The receiving antenna is moved around the axis line and the distance of the output voltage is measured and graph is plotted.
4. A sectorial antenna is need as receiver antenna and the angle output voltage are measured an graph is plotted.

Block Diagram:

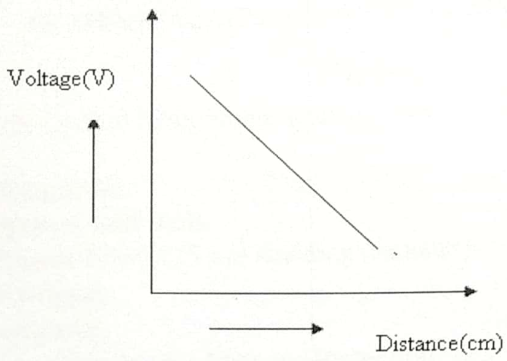


Tabulation:

Sl. No.	Distance	Output Voltage
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Sl.No.	Angle	Output (mV)
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Model Graph:



Result:

Thus the characteristics of a Horn antenna were studied.

OPTICAL COMMUNICATION

Experiment No: 6 **Date:**

NUMERICAL APERTURE DETERMINATION FOR FIBERS

AIM:
To measure the Optical Fiber Numerical Aperture.

Apparatus Required:

Equipment and tools

- Multimode fiber (125 μm cladding diameter)
- Fiber stripper
- Fiber cleaver
- Microscope setup for fiber end inspection
- Laser (Helium-Neon gas laser emitting at 632.8 nm)
- Optical breadboard
- Optical mounts (posts, post holders, fiber holders, fiber xy-positioner)
- Rotational stage
- Optical power meter and detector head
- Ball drivers and screws

Introduction
In this very first fiber-optic "experience," you will learn how to handle telecommunications-grade optical fibers and prepare fiber-ends for light coupling. You will get your first hands-on experience with building an optical setup on an optical breadboard. You will inspect the fiber cross-section using a microscope and measure the fiber numerical aperture (NA).
Fiber NA measures the cone of light ray that can be collected and transmitted in an optical fiber. Lecture 2 explains the concept of NA.

Before measuring fiber NA, it will be necessary to prepare the fiber ends so that light can be in/out-coupled via flat end-faces. This is done by a "scribe-and-break" technique to cleave the fiber. A diamond blade of the fiber cleaver is used to start a small crack in the fiber. The fiber is then pulled to propagate the scribe across the fiber cross section.

***Lab safety (This should apply to ALL labs)**
Common sense precaution will make fiber-optic experiments a safe and fun experience.

- Never look directly into the laser beam. The laser beam power used in 4620 experiments is on the order of mW (about that of a laser pointer). You can always trace the visible laser beam by using a piece of white paper. Use a sensor card to trace the infrared laser beam in later experiments.
- It is a good idea to wash your hands after the experiments. There is always some tiny plastic and glass debris after you strip and cleave the fiber.

Procedure

Preparing fiber ends

1. Remove about 3" of fiber jacket (a thin plastic coating) from a length of multimode fiber using the fiber stripper.
2. Use the fiber cleaver to cleave the stripped fiber end. Press the cleaver blade (white in color) **very gently** by using the cleaver arm (just touch the fiber with the blade). You are only starting a small "nick," which will propagate across the fiber cross section when you pull the fiber. Gently pull the fiber to finish the cleaving by carefully bending the base of the cleaver. *Note that you should not attempt to cut the fiber with the blade. This will give you a rough fiber cut*, which may degrade the fiber in/out-coupling and make your fiber NA measurement inaccurate.
3. Check the quality of the cleaved fiber end by examining it under a microscope. The fiber end-face should appear flat and be free of defects (such as glass debris or cracks). Cracks near the fiber sidewall are generally acceptable if they do not extend into the core region of the fiber.

   Common reasons for obtaining a poor cleave are as follows: (a) a poor scribe, and (b) a non-uniform pull of the fiber.

   A scribe that is too deep may cause an irregular cleave. If the pull is non-uniform (e.g. the fiber is twisted), irregularities may show up on the fiber end-face, typically with a "lip" at the fiber sidewall.
4. Repeat steps 1 – 3 for the other fiber end.
5. Now view a fiber end under the microscope. Use a lamp to illuminate the other end of the fiber. You will be able to see the light shining through the central portion of the fiber. This is the fiber core. The region surrounding the core is the fiber cladding. You would not see the plastic jacket. (You have already stripped it!)
6. **Sketch the fiber cross-section on your notebook**. Use a ruler to measure the core and cladding diameter on the screen. Record your measurement and calculate the ratio of core to cladding diameter. Given a cladding diameter of 125 μm, calculate the core diameter.

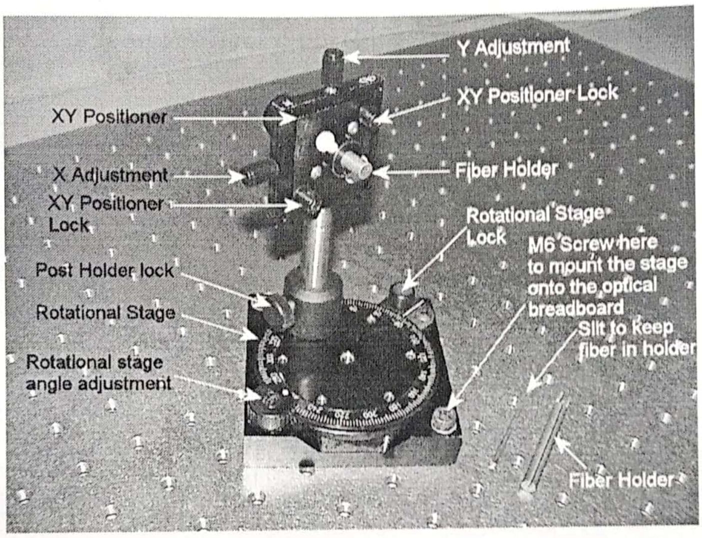
Measuring Fiber Numerical Aperture

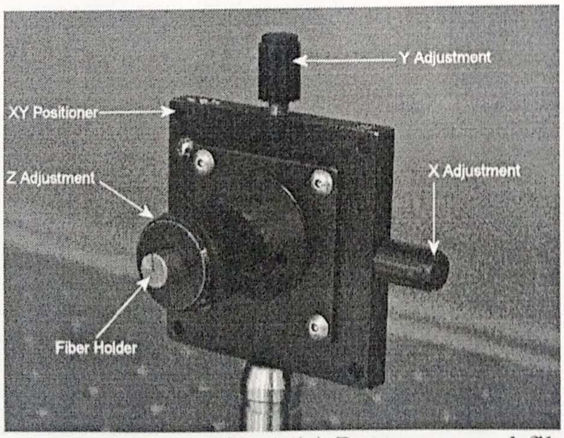
1. Set up the laser such that the laser beam propagates parallel to a line of holes on the breadboard, and the beam is at a reasonable height of about 10 cm above the breadboard. Use a piece of white paper to help locate and trace the laser beam. (*Switch on the laser at the beginning of the lab and leave it on until the end of the session. These lasers could be damaged if you switch it on and off too often!*)
2. Mount the rotational stage to the breadboard **so that the laser beam passes over the center hole (i.e. the origin) of the stage**. *It is a good idea to confirm the beam position by placing a piece of white paper at the centre of the stage*. The stage will need to be placed at an angle to the line of holes (see Fig. 1(a)).
3. Mount the post holder on the stage. Place a post-mounted fiber positioner on the rotation stage, as shown in Fig. 1 (a). Play and get familiar with all the knobs. Figures 1 (b) and (c) show the fiber positioner front and back views. Make sure you also try the z-adjustment.

4. Insert one end of the cleaved fiber into the fiber holder (the gold cylinder). Note that you will need to have stripped at least 6 cm of the fiber jacket. Let about 1 cm of the fiber tip extend from the holder. Insert the slit to hold the fiber in place.
5. Place the fiber holder into the fiber positioner. Gently tighten the fiber holder lock on the positioner (the white plastic screw). Try moving the fiber holder using the x, y, and z adjustment knob. [It is a good idea to adjust the XY positioner to the center for maximum freedom of X-Y movements for later fine tuning. Same for the Z-axis, though it may not be necessary for this lab. [Note that there is a mechanical limit of the adjustment, which should not be exceeded to avoid damage to the equipment.]
6. Orient the fiber positioner so that the fiber tip is above the center (i.e. the origin) of the rotational stage, as shown in Fig. 2. You may need to use the x, y and z adjustment. **This is a critical step in order to obtain an accurate value for the laser beam incidence angle and thus the fiber NA**. Confirm the alignment of your light-launching system by making sure that the fiber tip remains near the center of the laser beam as the stage is rotated in both positive and negative directions. **In your report, explain why the fiber tip position above the rotational stage is critical to the NA measurement**.
7. Insert the far end of the fiber in another fiber holder. *It is a good idea to leave about 1 cm of fiber end outside the fiber holder*. Mount and lock this fiber holder into another fiber positioner. Mount the positioner on the breadboard using a post holder.
8. Observe the output light from the fiber end using a piece of paper at a few-cm distance. **Measure the size of the output light pattern. Measure the distance between the fiber tip and the pattern. Estimate the cone angle of the output light from your measurement**. *This allows a quick and simple estimation of the fiber NA.*
9. **Sketch in your notebook (and in your report) the light pattern that you observe from the fiber.** Compare this with the laser beam before the laser enters the fiber. Discuss your observation in your report.
10. Mount the detector (photodiode) head of the power meter so that the output light from the fiber is incident on the detector head. Make sure the light pattern is entirely within the sensor chip. Figure 3 shows the detector head and the power meter. You may select one of the available power ranges for display (max. power 1 μW, 10 μW, 100 μW and 1 mW). Figure 4 shows the complete experimental setup.

11. Before you proceed with the NA measurement, you may maximize the laser power coupling to the fiber by fine-tuning the xy-positioner and the rotational stage recursively. *Note that the alignment process may take about 5 to 10 minutes depending on the alignment of every single piece of equipment. (The minimum optical power output from the fiber should be about 10 μW before you proceed with the measurement.)*
12. Use a piece of ***black paper*** to surround the detector head to keep stray room light off the detector. **Measure and record the detector background level** by blocking the laser beam at the input. *You will need to subtract this background from all of your data in your data analysis.*
13. **Measure and record the power accepted by the fiber as a function of the laser beam incident angle** (as measured by the rotational stage with 2° intervals). *It is important that you use both positive and negative rotation directions in order to compensate for any laser-fiber misalignment.* Measure and record as many data points as possible until the power measured is practically at the detector background level.

14. **In your report, plot the power received by the detector (after subtracting background) as a function of the measured incidence angle**. Measure the full width of the curve at the points where the received power is about 5% of the maximum received power. Here we define the half-width at this power as your measured ***fiber acceptance angle***. The sine of this acceptance angle is the measured fiber ***numerical aperture***. Compare this measured NA to an estimated NA based on step 8. Compare your measured and estimated NA with an accepted NA from fiber specifications found in the ELEC4620 website (see "Labs").
15. **In your report, discuss any measurement uncertainty.**





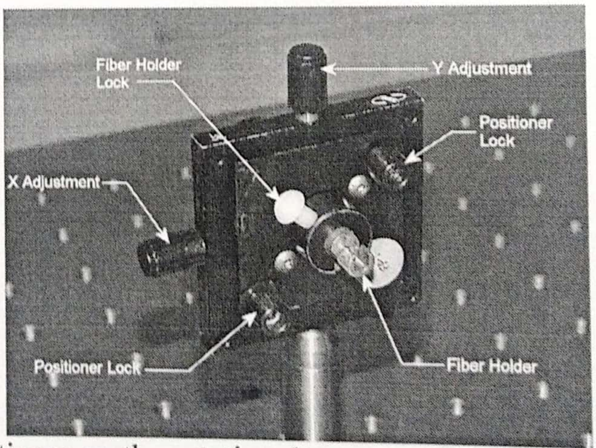


Fig. 1 (a) Post-mounted fiber positioner on the rotational stage

Fig. 1 (b) xy-positioner front view

Fig. 1 (c) xy-positioner back view

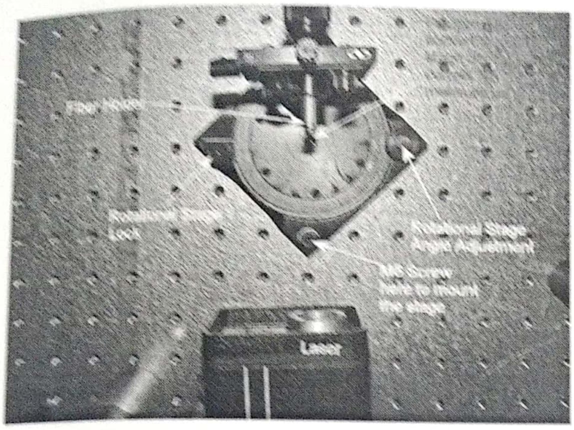


Fig. 2. Position the fiber tip above the rotational stage center.

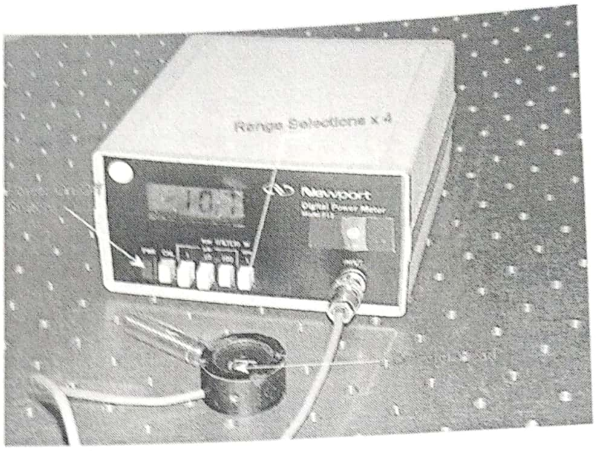


Fig. 3. Power meter and detector head

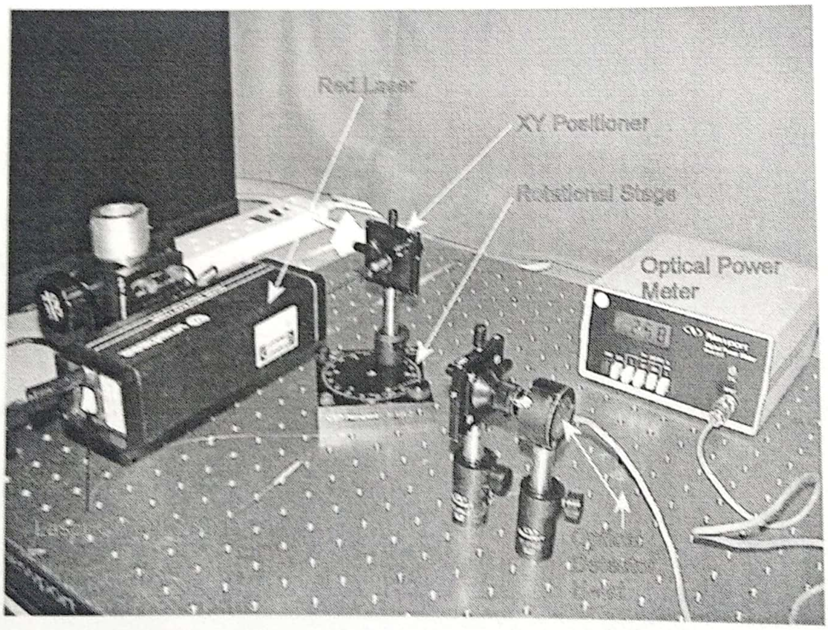


Fig. 4. Experimental setup

Result:

Thus numerical aperture is determined.

Experiment No: 7 **Date:**

DC CHARACTERISTICS OF LED

AIM:

To find the VI characteristics of given LED.

APPARATUS REQUIRED:

1. Optical trainer kit
2. Ammeter
3. Voltmeter

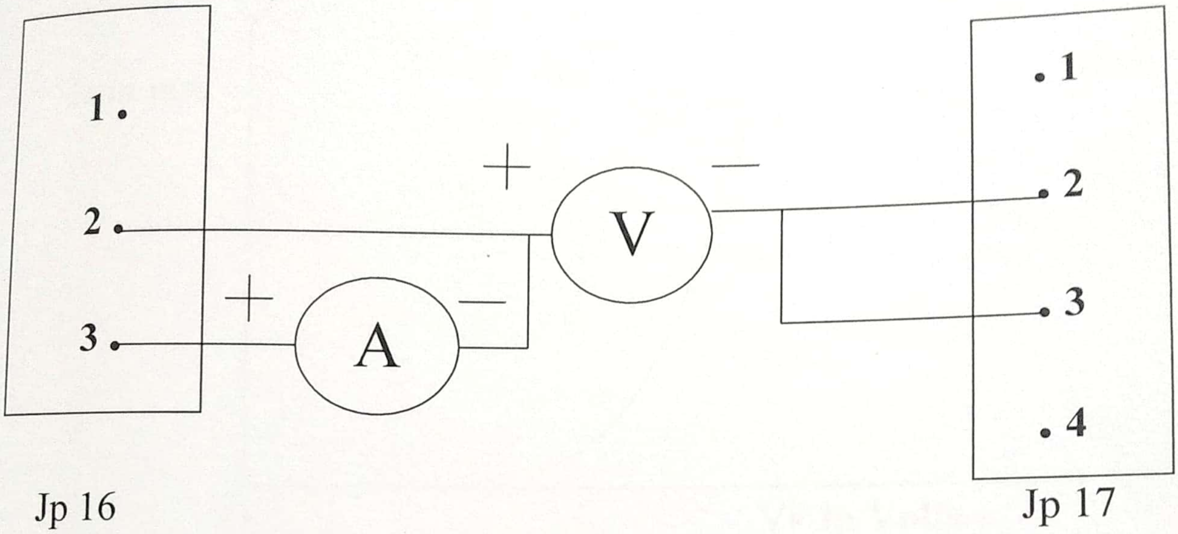
PROCEDURE:

1. Make the jumper settings as shown in figure.
2. Insert the sockets to connect the jumpers JP17 & JP16 as shown in figure.
3. Keep the potentiometer Pr 10 to its minimum position.
4. By varying slowly Pr 10 to clock wise direction note down the readings between voltage and current.
5. Plot the graph V_F *Vs* I_F.

RESULT:

Thus the VI characteristics of LED were found and graph was plotted.

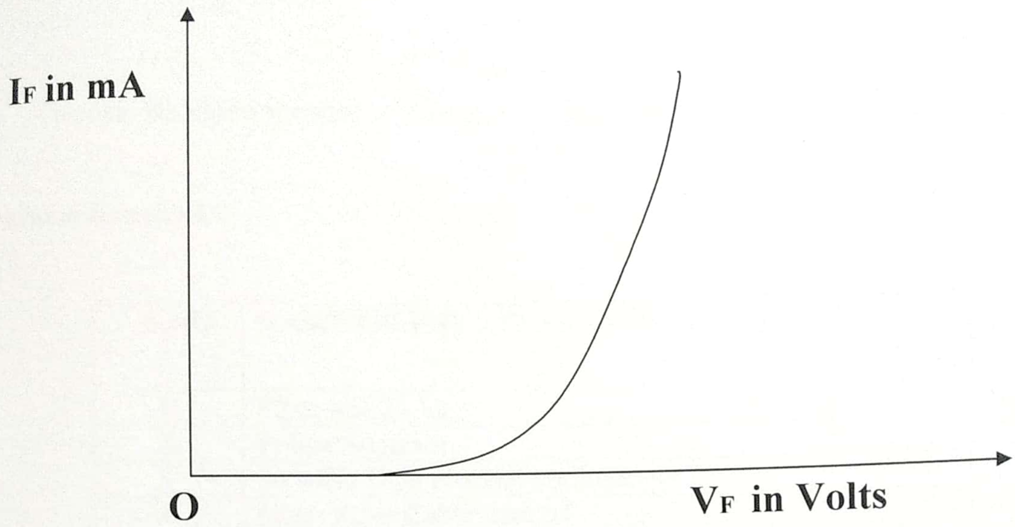
SEP UP DIAGRAM OF LED CHARACTERISTICS:



TABULAR COLUMN:

S.No.	FORWARD VOLTAGE (V_F in Volts)	FORWARD CURRENT (I_F in mA)

MODEL GRAPH:



Result:

Thus dc characteristics of LED are studied.

Experiment No: 8 **Date:**

CHARACTERISTICS OF PIN PHOTO DIODE

Aim:

To study the characteristics of PIN photo diode.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Fiber link E- kit	2
2.	Power Supplies	2
3.	20 MHz Dual channel oscilloscope	1
4.	Glass Fiber Cable with ST connector	1
5.	Function Generator kit	1
6.	Ammeter (0-30)mA,	1
7.	Patch cords	10

Theory:

In Optical Fiber communication system, Electrical signal is first converted into optical signal with the help of E /O conversion device as LED or photo Diode here. After this signal is transmitted through Optical Fiber, it is retrieved in its original electrical form with the help of O/E conversion device as Photo detector.

Optical Output vs. Forward/Output Current:

As the Forward current applied to a semiconductor diode is increased, photon oscillation begins at a certain Threshold, causing optical emission. This Threshold current is called starting current. The optical output power proportional to the forward current rises exponentially with temperature, increasing approx. 20 mA over a 50° C temperature variation.

Procedure:

Optical Output vs. Forward / Output Current:

1. Confirm that the power switch is in OFF position and then connect it to the kit.
2. Make the jumper settings and connections as shown in figure.
3. Insert the jumper connecting wires (provided along with the kit) in jumper JP1, JP2 and JP3 at positions shown in the diagram.
4. Keep the potentiometer P5 in anticlockwise rotation is used to control intensity of photo Diode.
5. Connect external signal generator to ANALOG IN post of Analog Buffer and apply sine wave frequency of 1MHz, 1Vp-p signal precisely.
6. Then connect ANALOG OUT post to ANALOG IN post of transmitter.
7. Then switch ON the power supply. Rotate P5 slowly and measure forward current and corresponding optical output power on power meter in dBm.
8. Take number of such readings for various current values and plot the Output power vs. Forward current graph for the photo Diode.
9. An oscillation begins at a certain Threshold, causing optical emission. This Threshold current is called starting current.
10. The signal power at the output angle polished connector may be varied in a 37dB dynamic range, -3dBm to -55dBm approx. for the modulated signal.

Block Diagram:

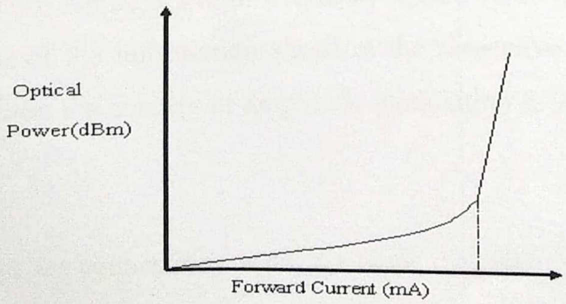
As in the photo diode circuit in the kit.

Tabulation:

S. NO	Input voltage (V) From LED	Output voltage(V) across photo diode

Model Graph:

MODEL GRAPH:



Result:

Thus characteristics of a photo diode have been determined.

Experiment No: 9 **Date:**

OPTICAL TRANSMISSION USING ANALOG MODULATION

Aim:

To obtain the amplitude modulation of analog signal, transmit over a fiber optic cable & demodulate the same at the receiver end to get back the original signal

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Experimental Kit1 &Kit2	1
2.	Power Supply	1
3.	20 MHz Dual channel oscilloscope	1
4.	Function Generator kit	1
5.	Fiber Cable(1m)	1
6.	Patch cords	10

Theory:

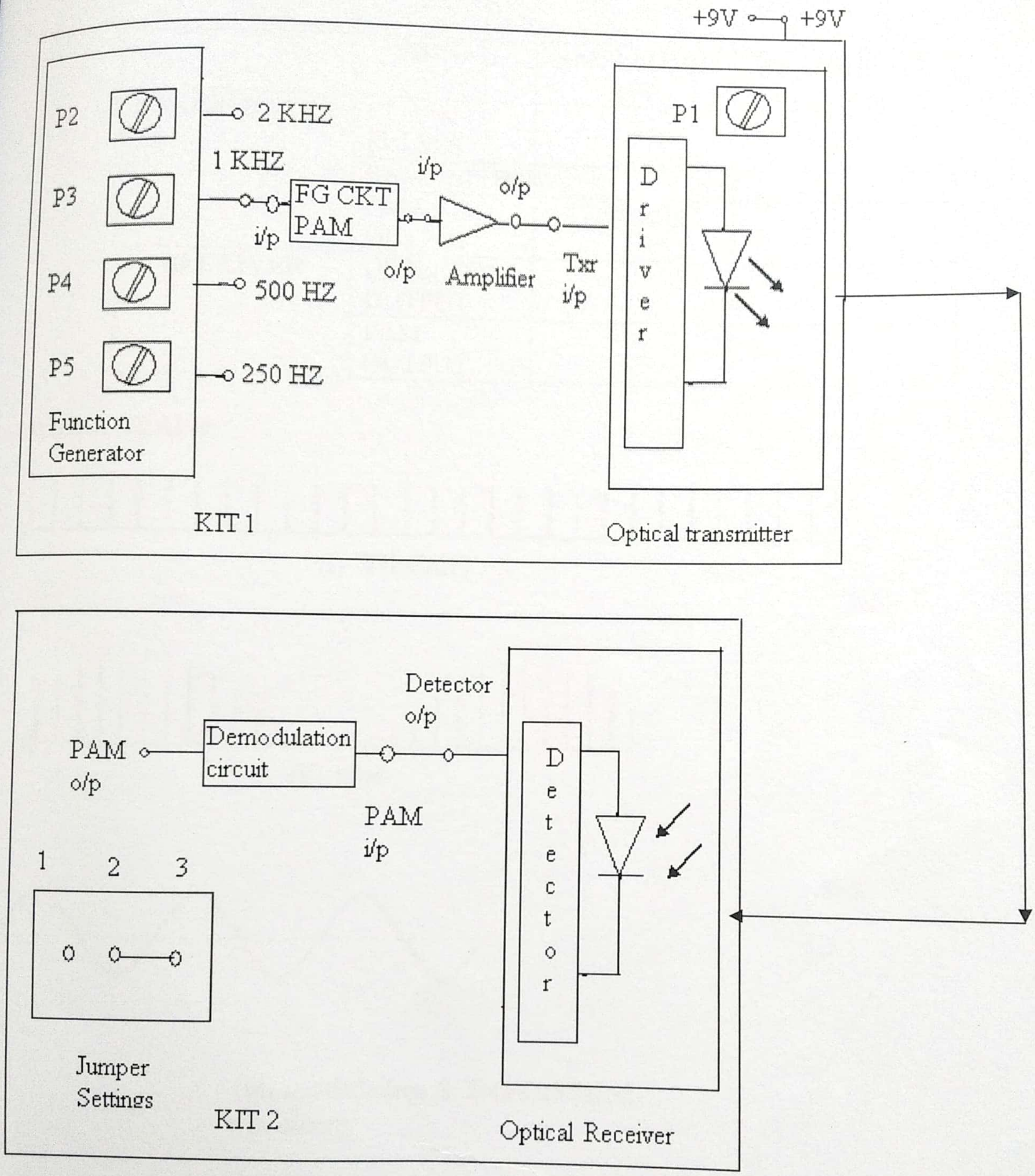
Pulse amplitude modulation is a technique of communication in which a high frequency signal is modulated in accordance with the message signal. The modulating signal is sampled by pulses. PAM signal is a high frequency square wave in which the amplitude of each pulse is equal to that of the information signal at the respective sampling instants. The block diagram clearly indicates the concept of amplitude modulation & demodulation.

Procedure:

1. Make the connections as per the block diagram
2. Connect the power supply cables with proper polarity to kit1& kit2. While connecting this, ensure that the power supply is OFF.
3. Connect 1 KHz to the PAM input.

4. Switch ON the power supply & CRO.
5. Check that the clock recovery circuit is working properly by connecting the CRO probe at the clock output post. You will find the square wave output
6. Observe the waveform at PAM output in which the square wave amplitude is varying in accordance with the sine wave input.
7. Connect the optical fiber cable between kit-1 & kit-2.Now establishes a link between amplifier output & transmitter input. While transmitting the signal, ensure that both the +9V are shorted by shorting links.
8. Observe the detector output in kit-2.
9. Observe the detector output in kit-2. Connect the output of the receiver to the input of pulse amplitude demodulator circuit by shorting detector output & PAM input in kit-2
10. Observe the output at PAM output in kit-2. We can find that the same sine wave is received. Thus the signal is pulse amplitude modulated, transmitted, received & demodulated successfully.

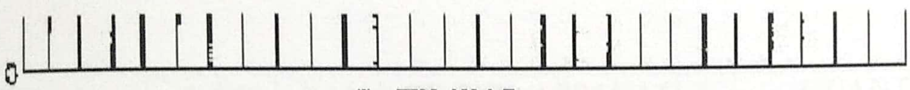
Block Diagram:



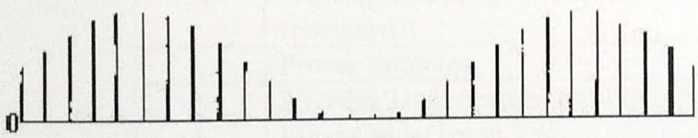
Tabulation:

	SIGNAL	AMPLITUDE (V)	FREQUENCY (KHz)
TRANSMITTER	CLOCK PULSES		
	PAM INPUT		
	PAM OUTPUT		
RECEIVER	DETECTOR OUTPUT		
	PAM OUTPUT		

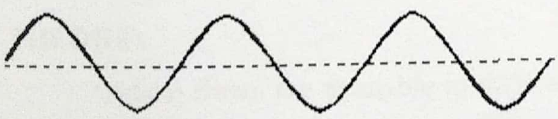
MODEL GRAPH:



(i) TIMING



(ii) PAM



(iii) modulating & Demodulated waveform

Result:

Thus the amplitude modulated analog signal is transmitted over a fiber optic cable & demodulated at the receiver end & the original signal is received

Experiment No: 10 **Date:**

DATA TRANSMISSION THROUGH FIBER OPTIC LINK

AIM:

To study the data transmission through fiber optic link and measure the following losses on the fiber.

1. Propagation loss.
2. Bending loss.
3. Connector loss.

APPARATUS REQUIRED:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Fiber optic analog transmitter & receiver kit	2
2.	Power Supplies	2
3.	20 MHz Dual channel oscilloscope	1
4.	Fiber Cable(1m & 3m)	1
5.	Function Generator kit	1
6.	Patch cords	10

THEORY:

Optical fibers are available in different variety of materials. These materials are usually selected by taking into account their absorption characteristics for different wavelengths of light. In case of optical fiber, since the signal is transmitted in the form of light, which is completely different in nature as that of electrons, one has to consider the interaction of matter with the radiation to study the losses in fiber. Losses are introduced in fiber due to various reasons.

PROCEDURE

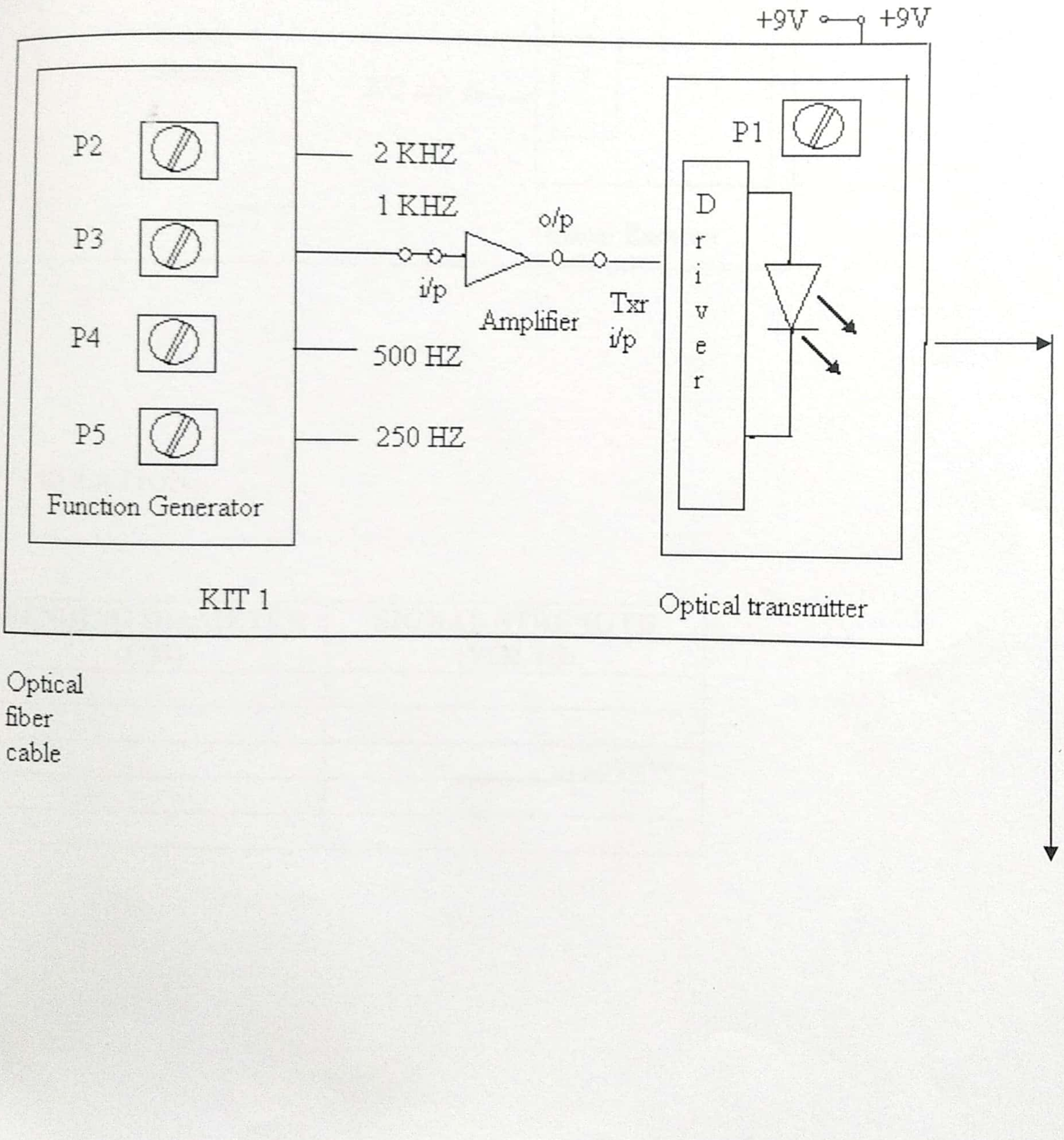
MEASUREMENT OF PROPAGATION LOSS

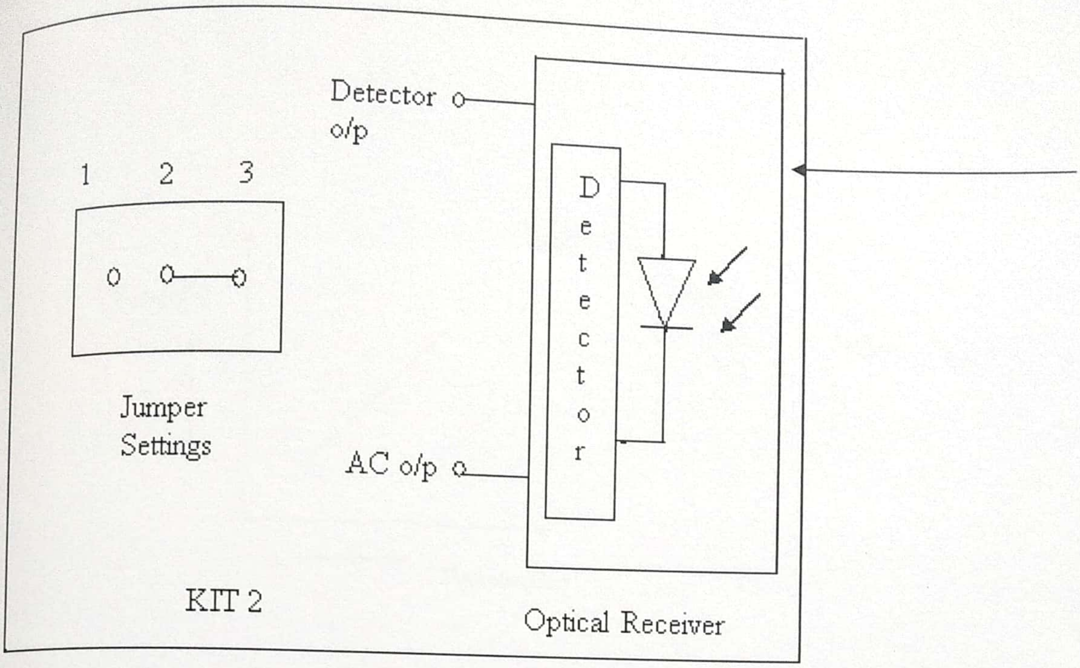
1. Make the connections as shown in figure.
2. Connect the power supply cables with proper polarity to transmitter and receiver kits while connecting this, ensure that the power supply is OFF.
3. Connect Function generator FG to transmitter kit using power cable.
4. Keep the jumpers JP1, JP2, JP3 and JP4 on transmitter kit shown in figure
5. Keep the jumpers JP1 and JP2 on receiver kit figure.
6. Keep switch S2 in TX IN position on transmitter kit
7. Switch ON the power supply.
8. Connect the 1 KHz, 2V (p-p) signal from FG to the IN post of Analog Buffer on transmitter kit
9. Connect the output of analog Buffer post OUT to TX IN.
10. Slightly unscrew the cap of LED SFH756 (660nm). Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap. Now tighten the cap by screwing it back.
11. Now rotate the Optical Power Control pot P3 in transmitter kit in anticlockwise direction. This ensures minimum current flow through LED.
12. Slightly unscrew the cap of Photo Diode SFH250V. Do not remove the cap from the connector. Once the cap is loosened, insert the other end of fiber into the cap. Now tighten the cap by screwing it back.
13. Observe the output signal from the detector at OUT post on oscilloscope by adjusting Optical Power Control pot P3 on transmitter kit and we should get the reproduction of the original transmitted signal.
14. Replace the 1 meter Fiber cable as 3 meter fiber and we get reproduction of sine wave with lower amplitude than 1 meter fiber output.
15. Take 1 meter fiber output voltage as V1 and 3 meter fiber output voltage as V2.
16. Power = 10 log (P2/P1) dB

MEASUREMENT OF BENDING LOSS:

1. Keep the connection as above procedure up to 13 steps.
2. Fold the Fiber cable in circle form.
3. Bend the cable to keep different diameter of circle. Say diameter of circle 10cm. 7cm. 5cm...
4. Tabulate readings and draw the graph for diameter Vs. Output voltages.

Block Diagram:

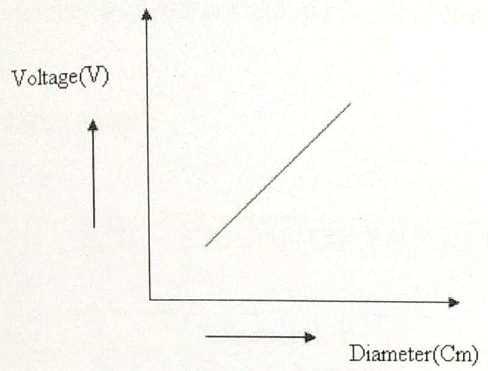




TABULATION:

BENDING DIAMETER (CM)	SIGNAL STRENGTH (VOLTS)

MODEL GRAPH:



RESULT:

Thus data transmission through fiber optic link is studied and propagation loss, bending loss & connector losses are measured.

Experiment No: 11 **Date:**

P-I CHARACTERISTICS OF LASER DIODE

Aim:

To determine Current versus Optical Power characteristics of a LASER diode.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Fiber link E- kit	2
2.	Power Supplies	2
3.	20 MHz Dual channel oscilloscope	1
4.	Glass Fiber Cable with ST connector	1
5.	Function Generator kit	1
6.	Ammeter (0-30)mA,	1
7.	Patch cords	10

Theory:

In Optical Fiber communication system, Electrical signal is first converted into optical signal with the help of E /O conversion device as LED or LASER Diode here. After this signal is transmitted through Optical Fiber, it is retrieved in its original electrical form with the help of O/E conversion device as Photo detector.

Optical Output vs. Forward/Output Current:

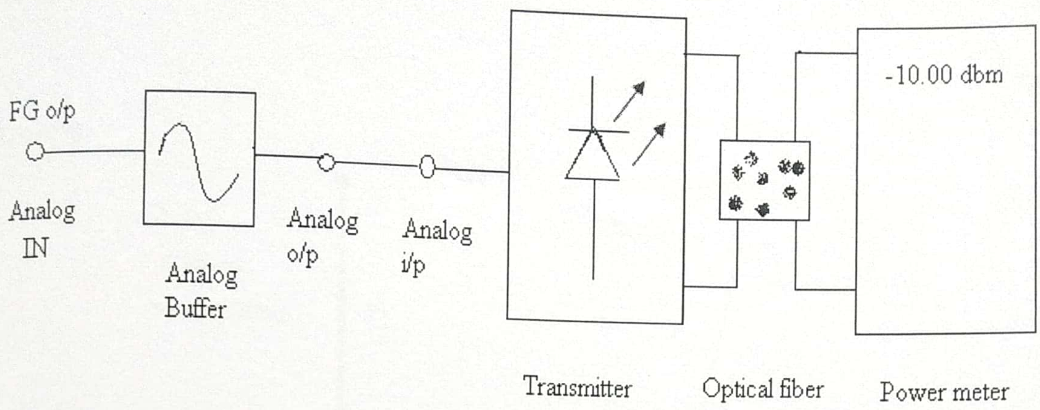
As the Forward current applied to a semiconductor LASER is increased, LASER oscillation begins at a certain Threshold, causing optical emission. This Threshold current is called starting current. The optical output power proportional to the forward current rises exponentially with temperature, increasing approx. 20 mA over a 50° C temperature variation.

Procedure:

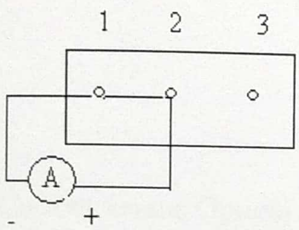
Optical Output vs. Forward / Output Current:

1. Confirm that the power switch is in OFF position and then connect it to the kit.
2. Make the jumper settings and connections as shown in figure.
3. Insert the jumper connecting wires (provided along with the kit) in jumper JP1, JP2 and JP3 at positions shown in the diagram.
4. Keep the potentiometer P5 in anticlockwise rotation is used to control intensity of LASER Diode.
5. Connect external signal generator to ANALOG IN post of Analog Buffer and apply sine wave frequency of 1MHz, 1Vp-p signal precisely.
6. Then connect ANALOG OUT post to ANALOG IN post of transmitter.
7. Then switch ON the power supply. Rotate P5 slowly and measure forward current and corresponding optical output power on power meter in dBm.
8. Take number of such readings for various current values and plot the Output power vs. Forward current graph for the LASER Diode.
9. An oscillation begins at a certain Threshold, causing optical emission. This Threshold current is called starting current.
10. The signal power at the output angle polished connector may be varied in a 37dB dynamic range, -3dBm to -55dBm approx. for the modulated signal.

Block Diagram:



Jumper diagram

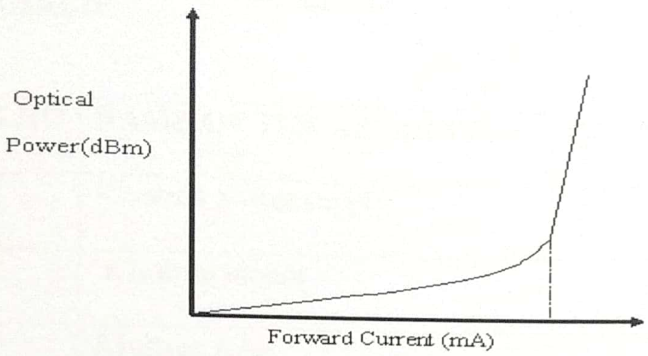


Tabulation:

S. NO	Forward Current (mA)	Optical Power (dBm)

Model Graph:

MODEL GRAPH:



Result:

Thus Current versus Optical Power characteristics of a LASER diode has been determined.

Experiment No: 12 **Date:**

CHARACTERISTICS OF VARIABLE ATTENUATOR

AIM:

To study the characteristics of a Variable Attenuator.

APPARATUS REQUIRED:

S.NO	NAME OF THE APPARATUS	QUANTITY
1	Klystron power supply	1
2	Klystron mount	1
3	Klystron tube	1
4	Frequency meter	1
5	Variable attenuator	1
6	Slotted section with probe carriage	1
7	Oscilloscope	1
8	Matched Termination	1
9	CRO	1

THEORY:

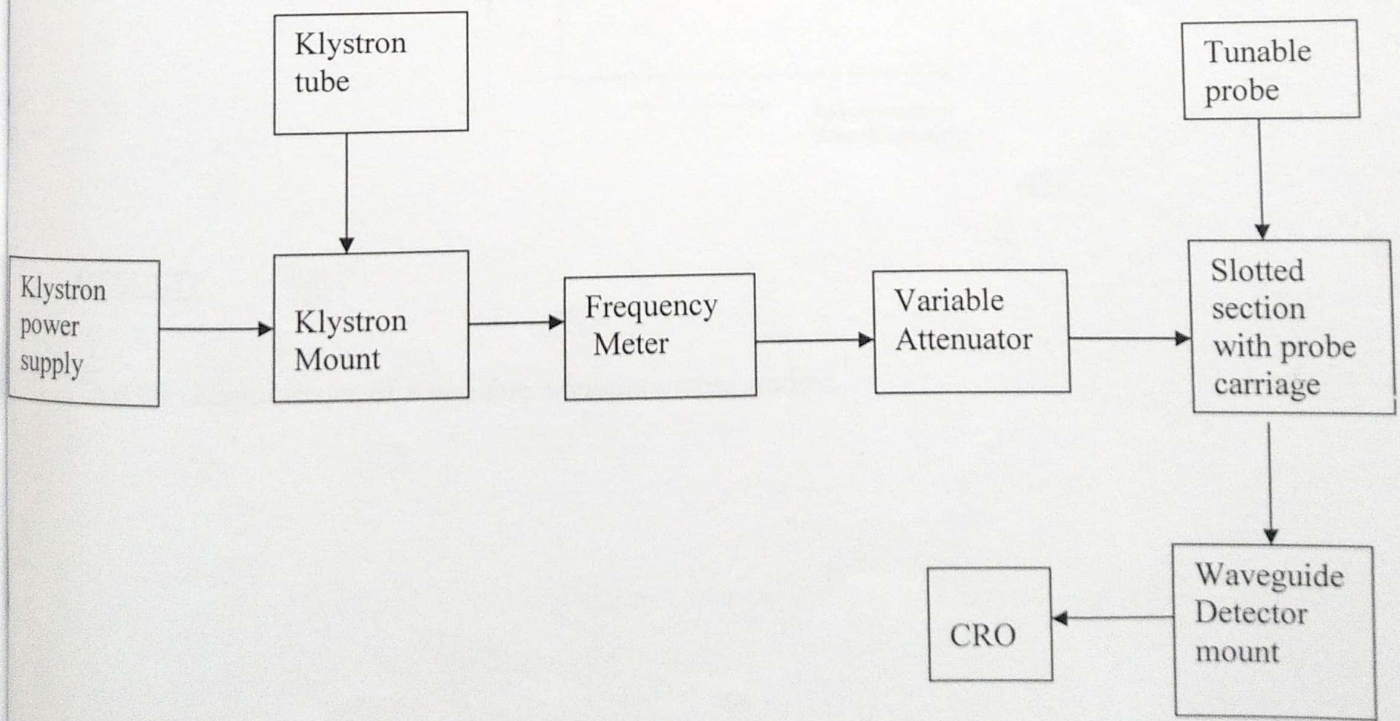
The attenuation of a device is the ratio of power into it to the output power. The input power measurement i.e. the power which actually enter the network there is as mismatch, there will be some power reflected but this is not attenuation. The total power reflected and power attenuated is called insertion loss. If there is no mismatch losses the insertion loss is equal to the attenuation is larger there is not much difference between attenuation and insertion loss ant the two terms are used interchangeably. Insertion loss of a network is the difference in power arriving at a load with and without the network in circuit.

PROCEDURE:

1. Set up the components as shown in the figure.
2. Set Variable attenuator at minimum attenuation position.

3. Set mode selection switch to AM- mid position beam voltage control knob fully anti-clockwise direction. Repeller voltage control to the maximum clockwise direction.
4. ON the klystron power supply, CRO and cooling fan.
5. ON the beam voltage switch and the voltage of 300V.
6. Keep the AM Mode and frequency knob at the mid position.
7. Set the upper voltage up to 210V deflection meter.
8. Increase the wave guide attenuation by tuning the micrometer anti-clockwise direction.
9. By varying attenuation at various points make the corresponding oscillator output voltage and record it.
10. Convert the output voltage in to the dB scale.

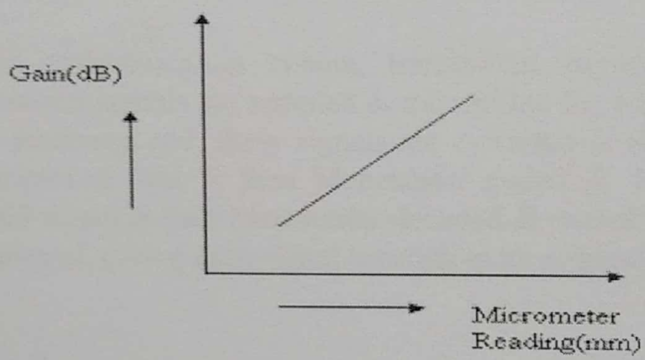
BLOCK DIAGRAM:



TABULATION:

Micrometer Reading (mm)	Output Voltage (V)	Gain = 20logVo (dB)

MODEL GRAPH



RESULT:

Thus the characteristics of a variable attenuator were studied

Experiment No: 13 **Date:**

STUDY OF TIME DIVISION MULTIPLEXING USING FIBER OPTIC

Aim:

To study the transmission of several signals of synchronous TDM using fiber optic.

Apparatus Required:

S.NO	NAME OF THE APPARATUS	QUANTITY
1.	Experimental Kit-4	1
2.	Power Supply	1
3.	20 MHz Dual channel oscilloscope	1
4.	Fiber Cable(1m)	1
5.	Telephone Handset	1
6.	Patch cords	10

Theory:

In case of communication system, transmitted signals carry voice or video information. In TDM, various signals are sampled & transmitted for a fixed duration of time one after the other. At the receiving end, these signals are extracted in the same order & form of transmission. The multiplexed data is then Manchester coded & fed as digital data to be transmitted. The received signal is then Manchester decoded & passed through a clock recovery circuit & then de-multiplexed, giving each signal separate in its original form & shape.

Procedure:

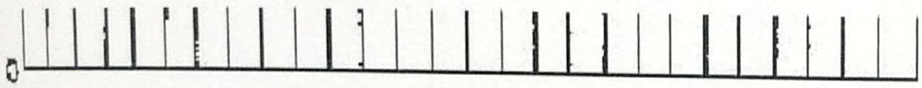
1. Make the connections as per the block diagram
2. Connect the 1m optical fiber cable between CRO SH750V (660nm) & detector SFH 551V (Digital Detector) to form 660nm digital link.
3. Make the jumper settings as shown in the diagram
4. Set marker to each bit pattern using SW1 & SW2 respectively.
5. Carefully observe the time duration for which each channel is Selected
6. Change the marker setting & observe the multiplexed data. Also observe how each marker is alternatively transmitted in each frame.
7. Press either of the top keys (K1, K2) & observe how data is transmitted in the corresponding time. Also observe how the signals are transmitted

at different points in each frame.

8. Observe the Manchester coded data at TP13. The received data which is still in Manchester coded form is available at TP22
9. Observe the data transmission by pressing TEES (K1, K2) & observing the LEDs V1 to V8 with this.
10. Hear the voice input at which the mount place being stooped back through the fiber to the jumper
11. Observe how data from audio channels shift on time slot of TP10

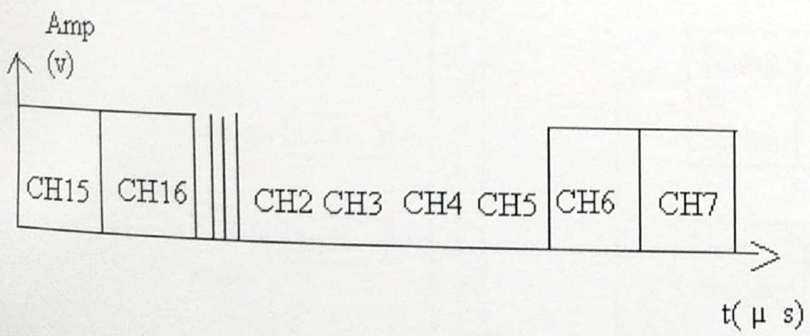
Model Graph:

TP13



(i) TIMING

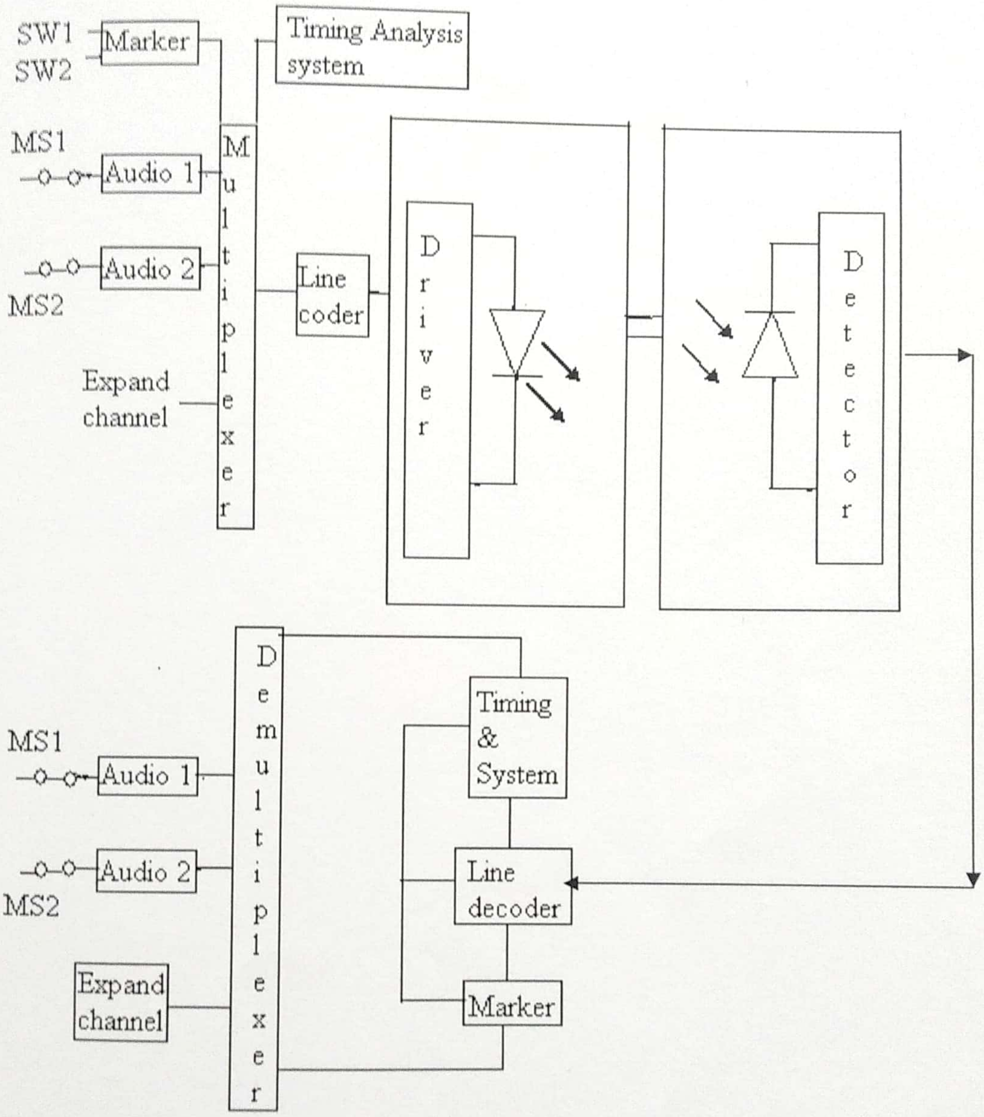
TP10



Tabulation:

PORT	AMPLITUDE	TIME PERIOD
TP10		
TP13		
TP22		

Block Diagram:



Result:

Thus the simultaneous transmission of several signals using synchronous TDM is studied.