MAHENDRA COLLEGE OF ENGINEERING, SALEM-106
DEPARTMENT OF ELECTRONICS AND
COMMUNICATION ENGINEERING

IV Year/ VII Semester

OPTICAL AND MICROWAVE LAB

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List of Experiments:

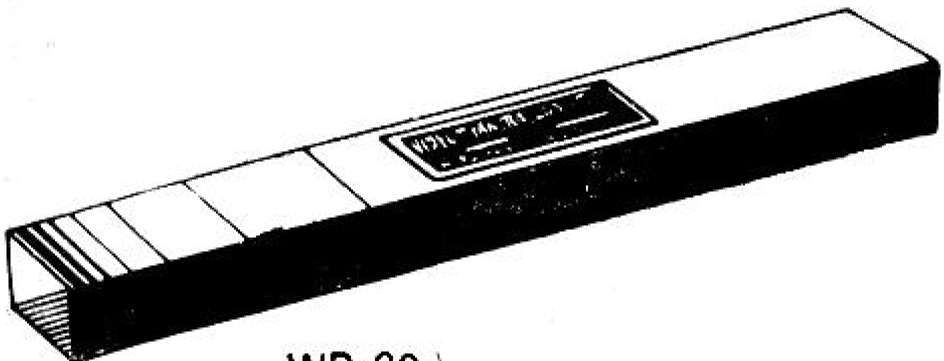
Ex. No: 1 STUDY OF MICROWAVE COMPONENTS

AIM:

To Study the Various Microwave Components.

RECTANGULAR WAVE GUIDE:

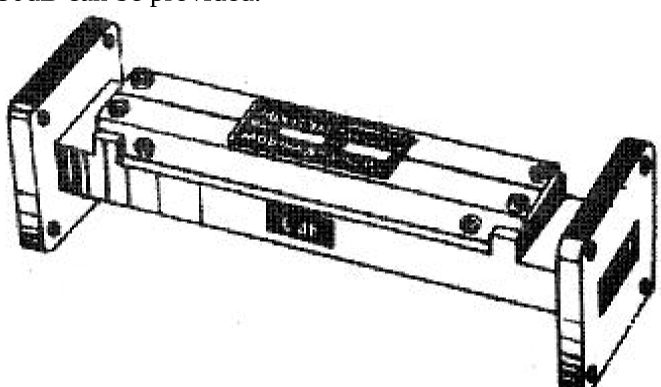
Wave guides are manufactured to the highest mechanical and electrical standards and mechanical tolerances. L and S band wave guides are fabricated by precision brazing of brass-plates and all other wave guides are in extrusion quality. W.G. sections of specified length can be supplied with flanges, painted outside and silver or gold plated in side.



WR-90

FIXED ATTENUATORS:

Series 5000 fixed Attenuators are meant for inserting a known attenuation in a wave guide system. These consists of a lossy vane inserted in a section of wave guide, flanged on both ends. These are useful for isolation of wave guide circuits, padding and extending the range of measuring equipments. Fixed Attenuators are available for 3,6 or 10 dB attenuation values, but any attenuation valve between 0 and 30dB can be provided.



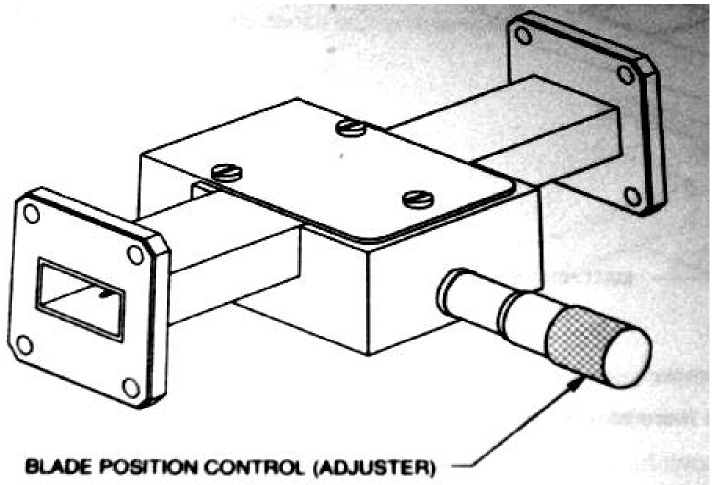
X-5000

VARIABLE ATTENUATORS:

Model 5020 are simple and conveniently variable type set-level attenuators to provide at least 20db (15db in V & W Bands) of continuously variable attenuation.

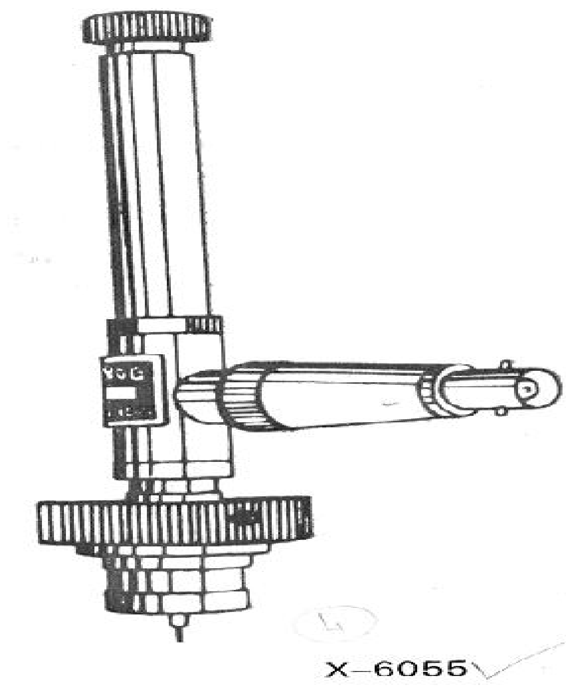
These consists of a movable lossy vane inside the section of a waveguide by means of a micrometer. The configuration of lossy-vane is so designed to obtain the low VSWR characteristics over the entire frequency band.

These are meant for adjusting power levels and isolating a source from the load etc.



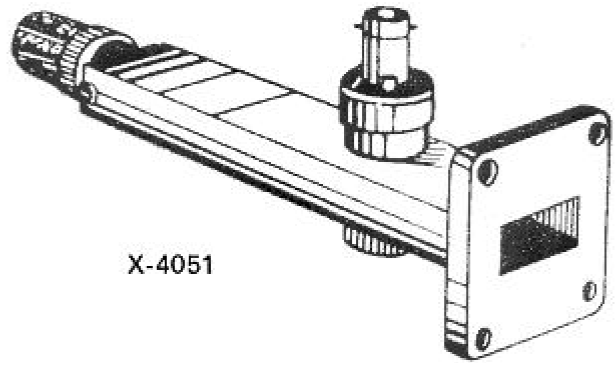
TUNABLE PROBE:

Model 6055 Tunable probe is designed for use with model 6051 slotted sections. These are meant for exploring the energy of the EF in a suitably fabricated section of wave guide. The depth of penetration into a wave guide - section is adjustable by the knob of the probe. The tip pick up the RF power from the line and this power is rectified by crystal detector, which is then fed to the VSWR meter or indicating instrument.



WAVE GUIDE DETECTOR MOUNT (TUNABLE):

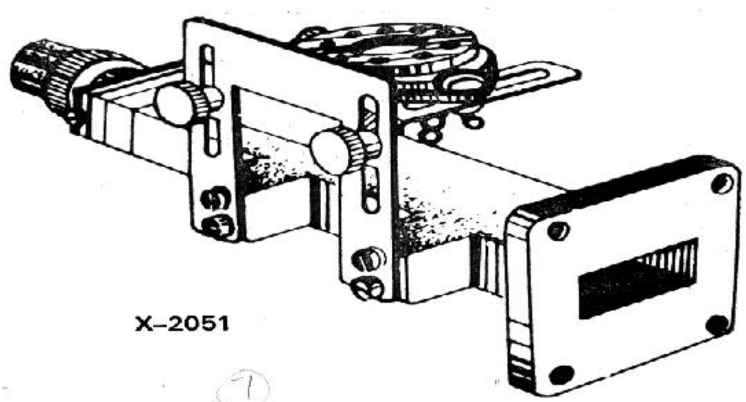
Model 4051 Tunable Detector Mount is simple and easy to use instrument for detecting microwave power through a suitable detector. It consists of a detector crystal mounted in a section of a Wave guide and shorting plunger for matching purpose. The output from the crystal may be fed to an indicating instrument. In K and R bands detector mounts the plunger is driven by a micrometer.



X-4051

KLYSTRON MOUNT:

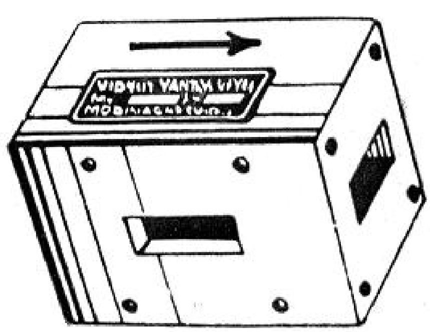
Model 2051 Klystron mounts are meant for mounting corresponding Klystrons such as 2K25, 723A/B, 726A or RK - 5976 etc. These consists of a section of wave guide flanged on one end and terminated with a movable short on the other end. An octal base with cable is provided for Klystron.



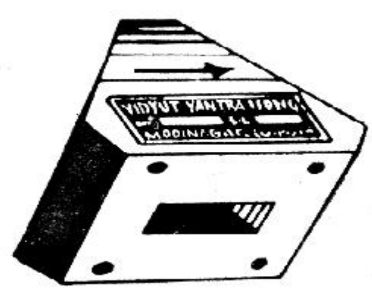
X–2051

CIRCULATORS

Model 6021 and 6022 are T and Y types of three port circulators respectively. These are precisely machined and assembled to get the desired specifications. Circulators are matched three port devices and these are meant for allowing Microwave energy to flow in clockwise direction with negligible loss but almost no transmission in the anti-clockwise direction.



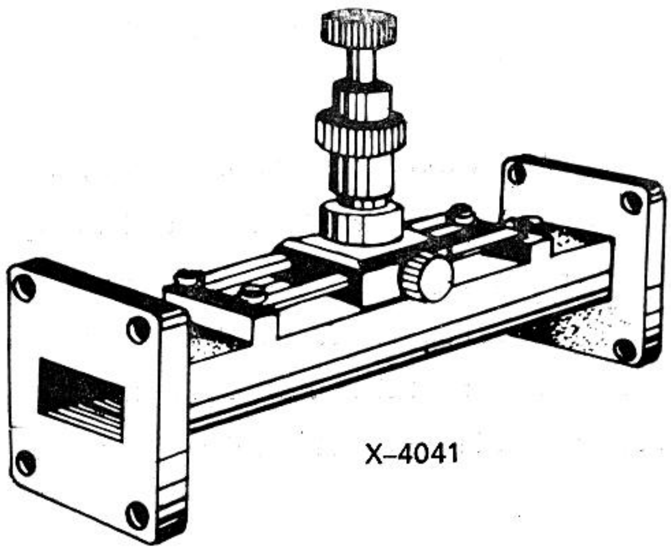
X-6021



X-6022

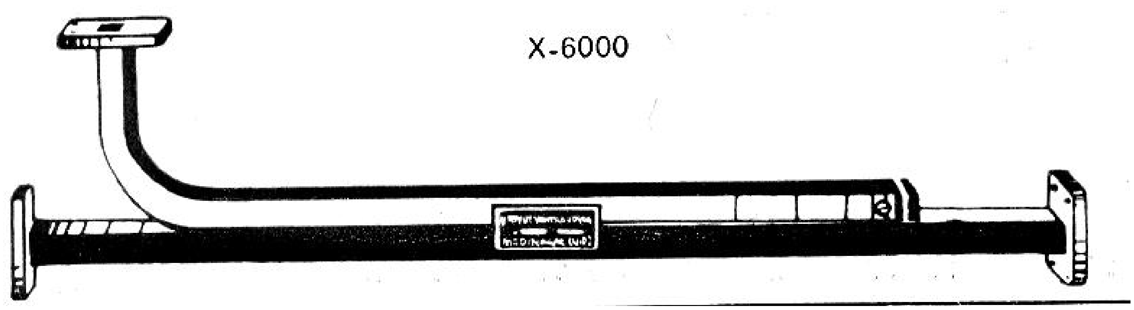
SLIDE SCREW TUNERS:

Model 4041 slide screw tuners are used for matching purposes by changing the penetration and position of a screw in the slot provided in the centre of the wave guide. These consists of a section of wave guide flanged on both ends and a thin slot is provided in the broad wall of the Wave guide. A carriage carrying the screw, is provided over the slot. A VSWR upto 20 can be tuned to a value less than 1.02 at certain frequency.



MULTIHOLE DIRECTIONAL COUPLERS:

Model 6000 series Multihole directional couplers are useful for sampling a part of Microwave energy for monitoring purposes and for measuring reflections and impedance. These consists of a section of Wave guide with addition of a second parallel section of wave guide thus making it a four port network. However the fourth port is terminated with a matched load. These two parallel sections are coupled to each other through many holes, almost to give uniform coupling; minimum frequency sensitivity and high directivity. These are available in 3,6,10,20 and 40dB coupling.

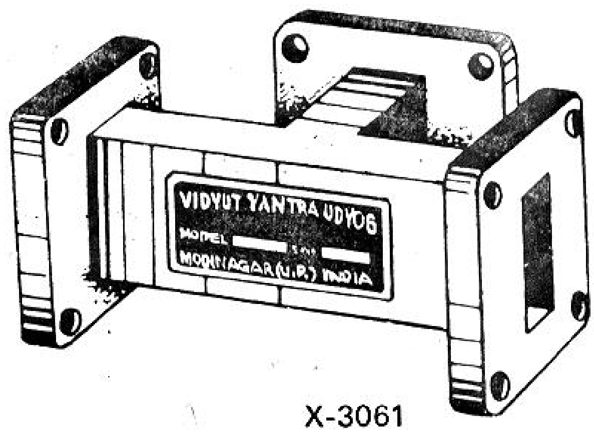


WAVEGUIDE TEES:

In microwave circuits, a waveguide or coaxial line junction with three independent parts is commonly referred as the junction. Waveguide Tee consists of E- Plane Tee, H-Plane Tee and Magic Tee.

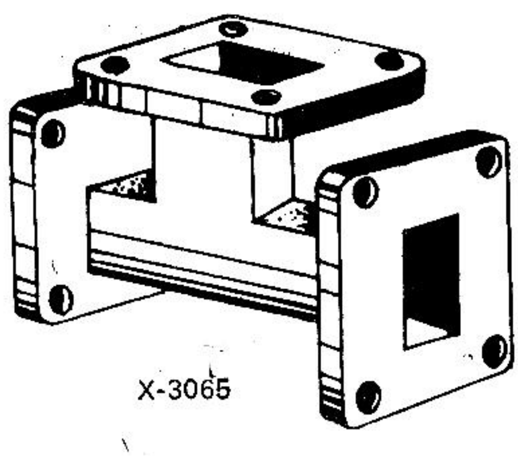
i) E PLANE TEE

Model 3061 E - plane tee are series type T - junction and consists of three section of wave guide joined together in order to divide or compare power levels. The signal entering the first port of this T - junction will be equally dividing at second and third ports of the same magnitude but in opposite phase.



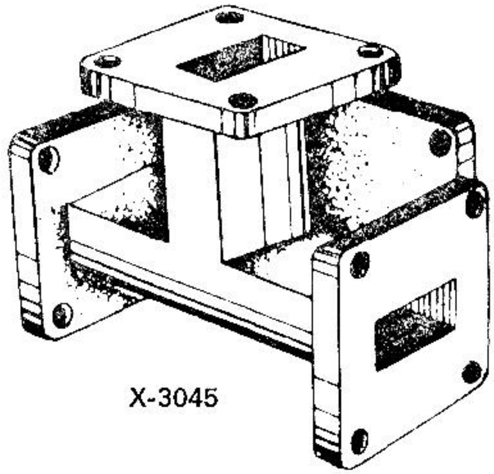
ii) H - PLANT TEE:

Model 3065 H - Plane Tee are shunt type T - junction for use in conjunction with VSWR meters, frequency - meters and other detector devices. Like in E-plane tee, the signal fed through first port of H - plane Tee will be equally divided in magnitude at second and third ports but in same phase.



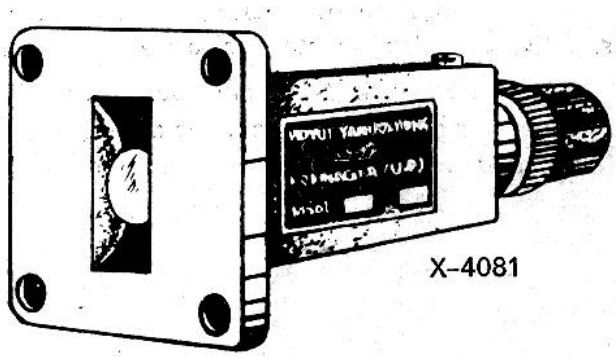
iii) MAGIC TEE:

Model 3045 E - H Tee consists of a section of wave guide in both series and shunt wave guide arms, mounted at the exact midpoint of main arm. Both ends of the section of wave guide and both arms are flanged on their ends. These Tees are employed in balanced mixers, AFC circuits and impedance measurement circuits etc. This becomes a four terminal device where one terminal is isolated from the input terminal.



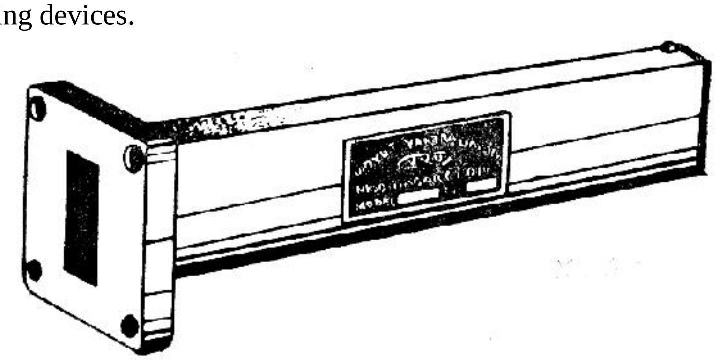
MOVABLE SHORT:

Model 4081 movable shorts consists of a section of waveguide, flanged on one end and terminated with a movable shorting plunger on the other end. By means of this non contacting type plunger, a reflection co-efficient of almost unity may be obtained.



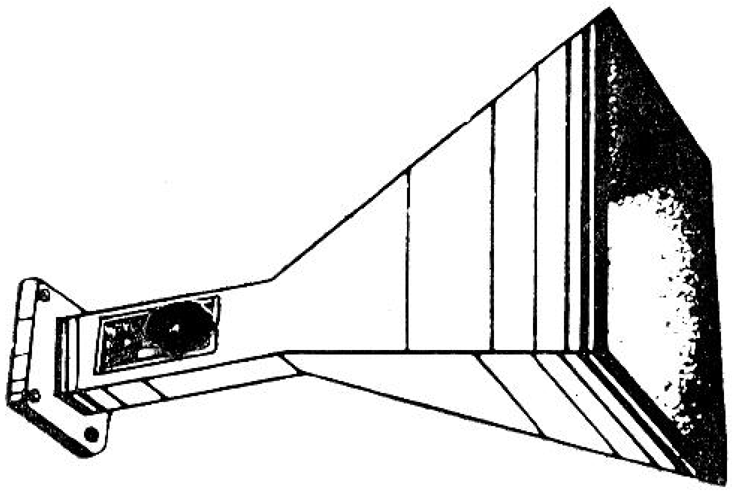
MATCHED TERMINATION:

Model 4000 are low power and non-reflective type of terminations. It consists of a small and highly dissipative taper flap mounted inside the centre of a section of wave guide. Matched Terminations are useful for USWR measurement of various waveguide components. These are also employed as dummy and as a precise reference loads with Tee junctions, directional couplers and other similar dividing devices.



PYRAMIDAL WAVEGUIDE HORN ANTENNA:

Model 5041 pyramidal Wave guide Horn antenna consists of waveguide joined to pyramidal section fabricated from brass sheet. The pyramidal section shapes the energy to concentrate in a specified beam. Wave guide horns are used as feed horns as radiators for reflectors and lenses and as a pickup antenna for receiving microwave power.



WAVEGUIDE BENDS:

It is used to change the direction of waveguide. Bends can be in E- Plane or H- Plane.

E- Bend **H- Bend**

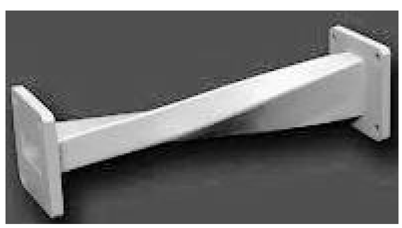
FREQUENCY METER:

Model 4155 Direct reading Frequency Meter are absorption type frequency meter to give direct frequency on dial provided. These are recommended for use whenever quick determination of frequency and easy readings are desired in laboratory and production testing.

These consists of a section of waveguide connected to a tunable resonant cavity of high Q. The cavity absorbs some power at resonant frequency.

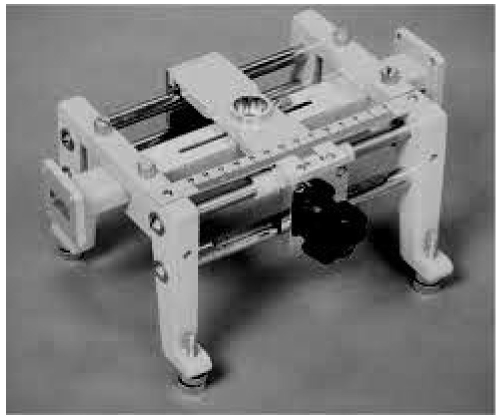
WAVEGUIDE TWIST:

Model 7051 wave guide Twist are used to change the plane of polarization of a propagating wave. Waveguide twists such as 90 degree and 45 degree twists are helpful in converting vertical to horizontal polarizations or vice versa.



SLOTTED SECTION:

Model 6051 slotted section consists of a precision waveguide slotted line and the probe-carriage. The waveguide slotted line, comprise of an accurately machined section of waveguide in which a small longitudinal slot has been cut which is a basic means for monitoring wave-patterns inside the waveguide system. Such data may be transformed into impedance of the terminal load of unknown system of components, percent of transmitted power, degree of antenna-match and other characteristics of waveguide. A precision built probe carriage has a centimeter-scale with a vernier reading of 0.1 mm least count and a dial gauge can be mounted easily if precise readings are required.

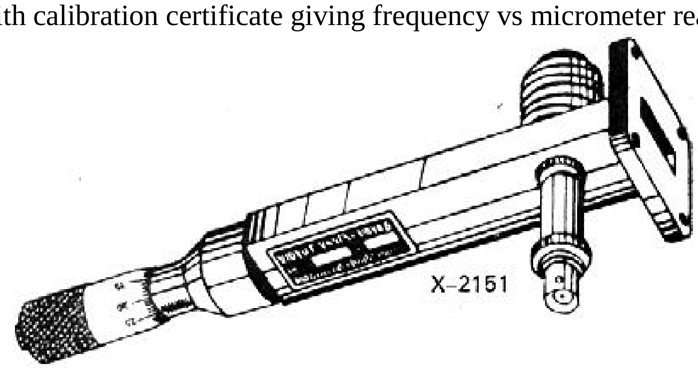


WAVEGUIDE STANDS:

Model 5035 waveguide Stands are meant to accept the components of respective bands for setting up a waveguide test bench and system. The height of stand is adjustable with a locking screw.

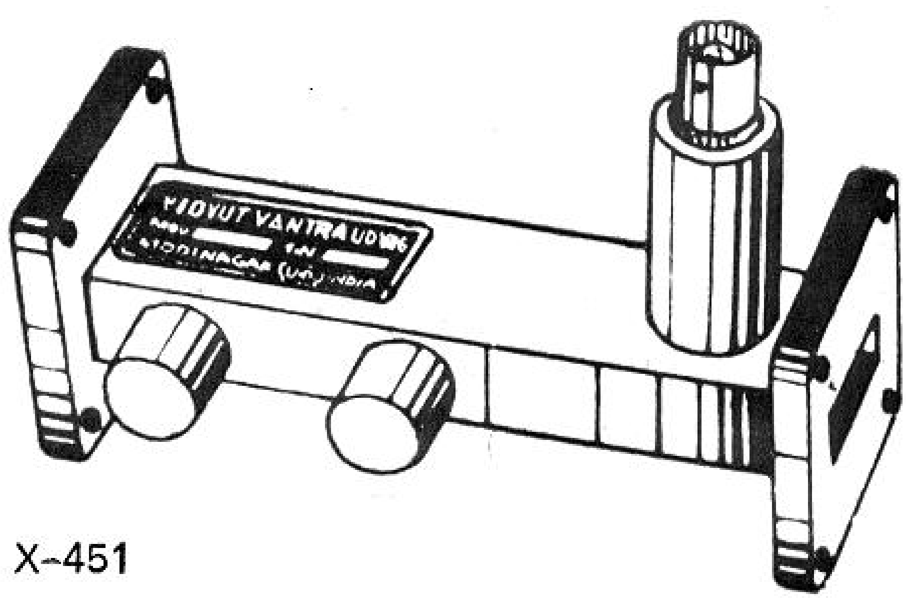
GUNN OSCILLATORS:

Model 2151 Gunn Oscillators are solid state microwave energy generators. These consists of waveguide cavity flanged on one end and micrometer driven plunger fitted on the other end. A gunn-diode is mounted inside the Wave guide with BNC (F) connector for DC bias. Each Gunn oscillator is supplied with calibration certificate giving frequency vs micrometer reading.



PIN MODULATORS:

Model 451 pin modulators are designed to modulate the CW output of Gunn Oscillators. It is operated by the square pulses derived from the UHF(F) connector of the Gunn power supply. These consists of a pin diode mounted inside a section of Wave guide flanged on it's both end. A fixed attenuation vane is mounted inside at the input to protect the oscillator.



X-451

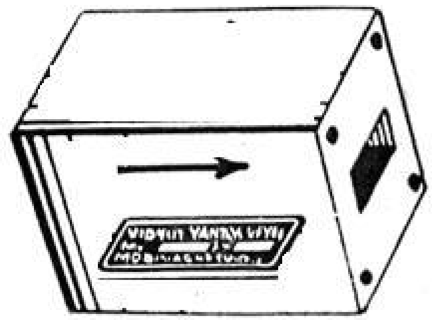
GUNN POWER SUPPLY:

Model X-110 Gunn Power supply comprises of an regulated DC power supply and a square wave generator, designed to operate Gunn-Oscillator model 2151 or 2152, and pin modulators model 451 respectively. The DC voltage is variable from 0 - 10V. The front panel meter monitors the gunn voltage and the current drawn by the Gunn diode. The square wave of generator is variable from 0 - 10V. in amplitude and 900 - 1100 Hz in frequency. The power supply has been so designed to protect Gunn diode from reverse voltage application over transient and low frequency oscillations by the negative resistance of the Gunn-diode.

X-110

ISOLATORS:

The three port circulators Model 6021 may be converted into isolators by terminating one of its port into matched load. these will work over the frequency range of circulators. These are well matched devices offering low forward insertion loss and high reverse isolation.



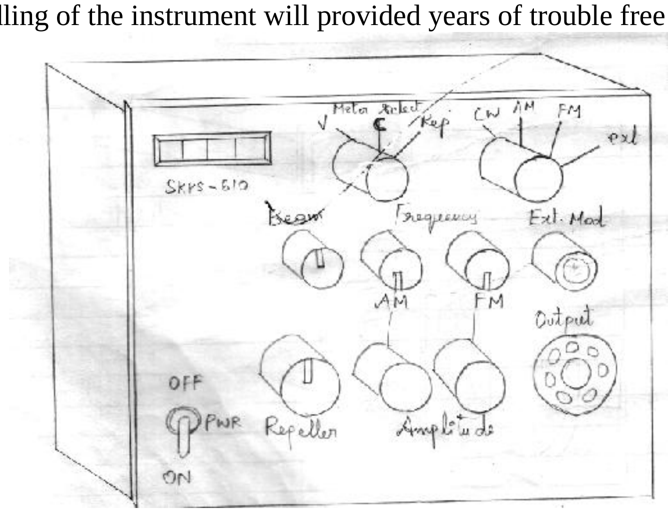
KLYSTRON POWER SUPPLY:

Model KP-151, is a state-of-the-art solid state, regulated power supply for operating low power Klystrons such as 2K25, 723 A/B, RK 5976, 726, 2K22 etc.

Model KP151 incorporates a number of proprietary features:-

A) Regulated Beam Supply, Repeller and Filament Supply voltages.
B) Overload TRIP protection for Beam Supply Output.
C) LED Digital metering for Beam voltage, current and Repeller voltage.
D) Stand-by mode.
E) Ultra compact and Reliable.
F) Modular construction for easy maintenance.

In addition to AM and FM modulation of Beam current, a provision for externally modulating the **klystron Supply** with desired signal waveform has been provided.
Model KP-1 51 utilizes quality components, rugged construction and ergonomically designed front panel. A careful handling of the instrument will provided years of trouble free service.



VSWR METER:

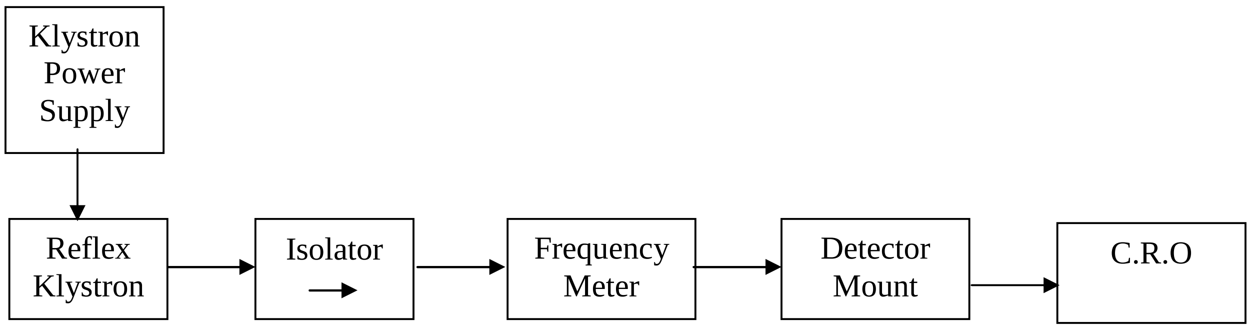
Model VS-411 is a calibrated high gain amplifier tuned at one frequency to be used for measurement of VSWR, impedance and relative power levels. The meter indicates the signal level in proportion to the input, which is calibrated directly in VSWR and db.

Input Selector Switch is provided for NORMAL and EXPAND range.

RESULT:

Thus the various microwave components were studied and analyzed with their corresponding functionality.

EXPERIMENTAL SETUP:



OBSERVATIONS:

Mode	Repeller Voltage (Volts)	Wave meter reading Frequency (GHz)	Output voltage (mV)
Mode 1			
Mode 2			
Mode 3			
Mode 4			

Ex. No: 2 **REFLEX KLYSTRON CHARACTERISTICS**

AIM:

To study the mode characteristics of Reflex klystron.

APPARATUS REQUIRED:

1. Reflex Klystron Power Supply.
2. Reflex Klystron with mount and cooling fan
3. Isolator.
4. Variable Attenuator.
5. Frequency meter.
6. Waveguide Detector.
7. CRO.
8. Wave guide stands and Cable accessories.

PROCEDURE:

1. Assemble the equipment as shown in experimental set up with CRO.
2. Switch on Klystron power supply for 1000 cycle square wave modulation of the signal.
3. Set the attenuator to suitable level
4. Apply the klystron reflector and beam voltage.
5. Set the beam voltage
6. Adjust the repeller voltage slowly from maximum -ve voltage to get maximum output in CRO.
7. Adjust the klystron mounting plunger and also the waveguide detector plunger to get a maximum output in the CRO
8. Adjust the AM modulation voltage & frequency knob to get maximum output in CRO.
9. Keep the repeller voltage knob fully clockwise
10. Slowly reduce repeller voltage to get small output in CRO. Note down the repeller voltage and peak to peak amplitude
11. Reduce the repeller voltage in steps of 2V and note down the peak to peak amplitude in CRO and repeller voltage
12. At each of the above steps measure the frequency by tuning the direct reading frequency meter to have dip in the square wave in CRO.
13. The frequency meter should be detuned each time after measuring frequency.
14. Repeat the steps from 11 and note down the readings for at least 3 modes of Reflex klystron.
15. Plot the graphs (a) Peak to Peak voltage Vs Repeller voltage (b) Frequency Vs Repeller voltage to get mode curves.

Model Graph:

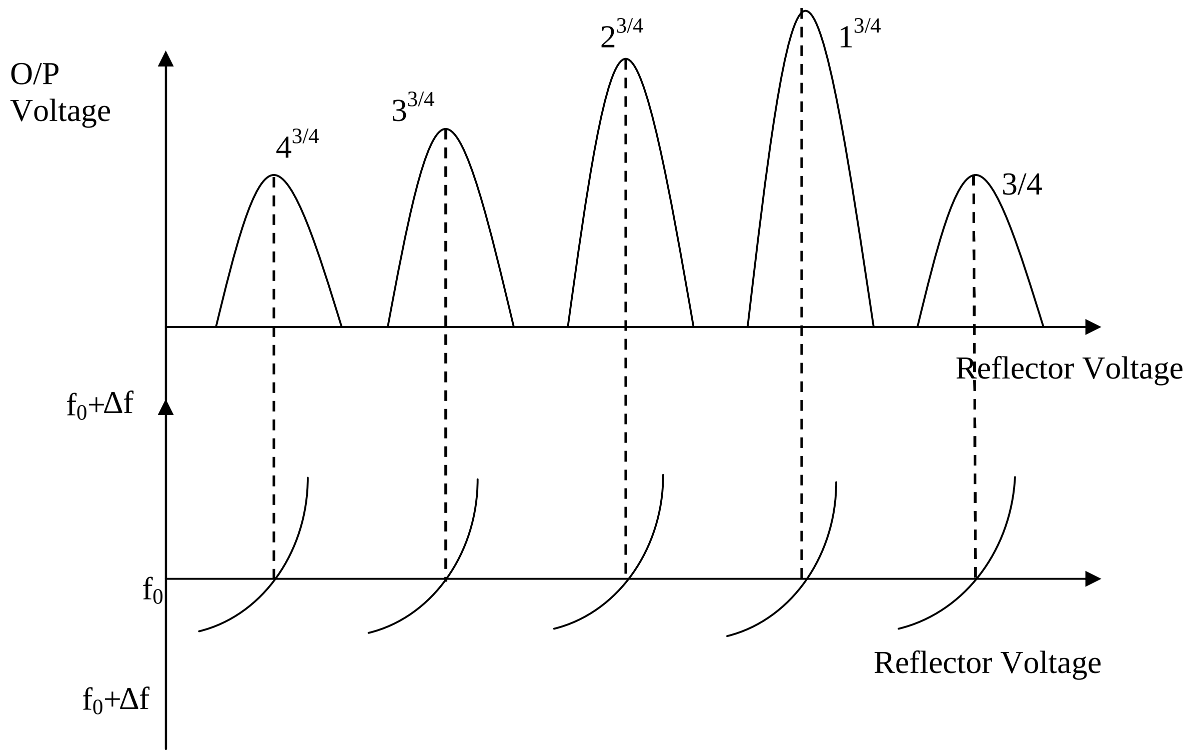


Fig: Mode Characteristics of Reflex Klystron

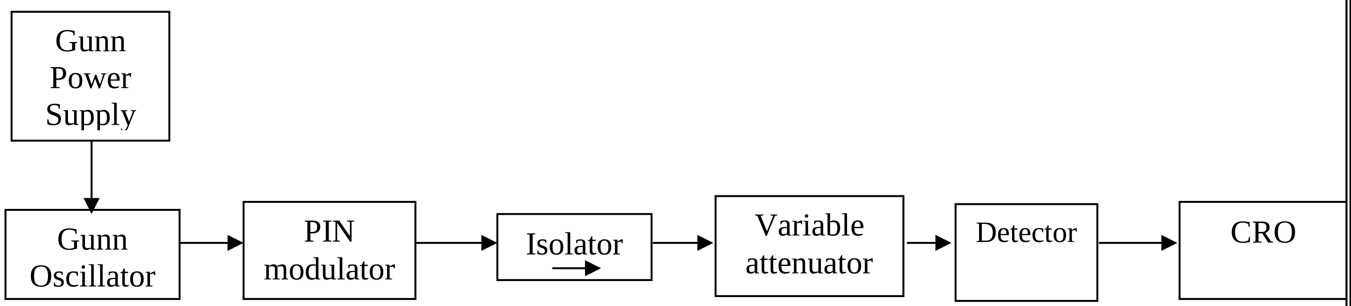
Result:

Thus the mode characteristics of reflex klystron have been studied and mode characteristics are plotted.

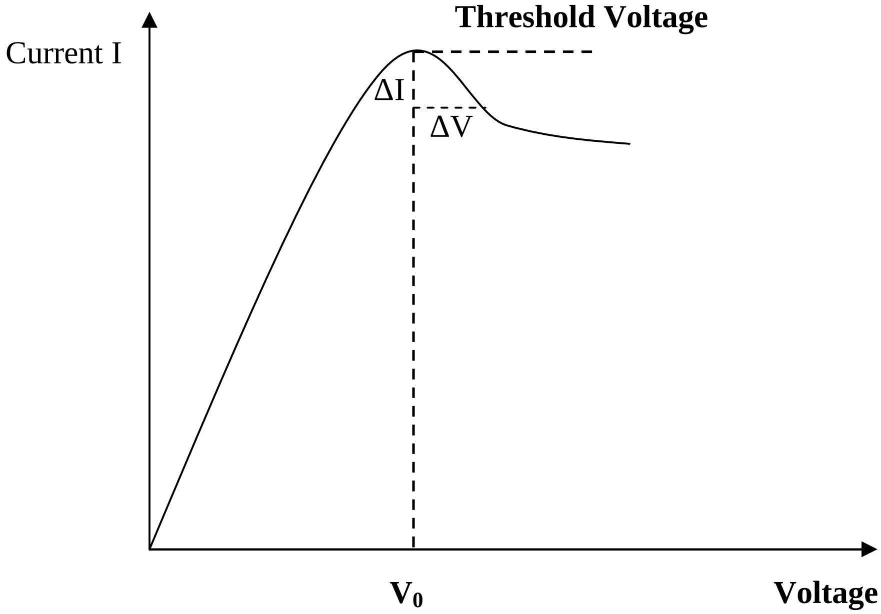
Model Viva Questions:

1. Define velocity modulation?
2. Define density modulation?
3. Discuss various applications of reflex klystron.
4. Give the efficiency of reflex klystron?
5. Define electronic tuning range?
6. What is the difference between mechanical tuning and electronic tuning?
7. Reflex klystron consists of how many cavities?
8. What are the advantages of reflex klystron over two-cavity klystron?
9. In Reflex klystron how can you change the frequency of operation?
10. What is the range output power?
11. In Reflex klystron which mode has highest power?
12. Why first mode is not used in a reflex klystron?
13. What is mechanical tuning with reference to reflex klystron?
14. What is electronic tuning with reference to reflex klystron?
15. How can you change the frequency in a reflex klystron?
16. Give the difference between reflex klystron and multi cavity klystron?
17. In slotted section through the slot in the upper broad wall , how much power escapes ?
18. How can you change a microwave reflex klystron to millimeter wave reflex klystron?
19. In the microwave bench a non linear detector is needed or not? Justify your answer?
20. Why three port isolator is used in the microwave bench?

EXPERIMENTAL SET UP :



MODEL GRAPH



Ex. No 3 GUNN DIODE CHARACTERISTICS

AIM: -

To Study the V-I characteristics of the Gunn oscillator and to determine the negative resistance.

APPARATUS REQUIRED:

1. Gunn Power Supply.
2. Gunn Diode.
3. PIN Diode
4. Isolator.
5. Variable Attenuator.
6. Frequency meter.
7. Detector

PROCEDURE:

1. Assemble the components as shown in experimental set up above.
2. Keep the control knobs of Gunn power supply as given below

Meter Switch	: OFF
Gunn Bias Knob	: Fully anticlockwise
PIN Bias Knob	: Fully anticlockwise

3. Set the micrometer of Gunn oscillator for required frequency of operation
4. Switch on the power supply.
5. Measure the Gunn Current corresponding to various Gunn bias voltage through the digital panel meter and meter switch. Do not exceed bias voltage above 10V.
5. Plot the voltage and current on the graph.
6. Negative resistance is calculated using the formula

$$R = \Delta V / \Delta I$$

Tabular column:

Gunn bias Voltage (V)	Gunn diode Current (mA)

Result:

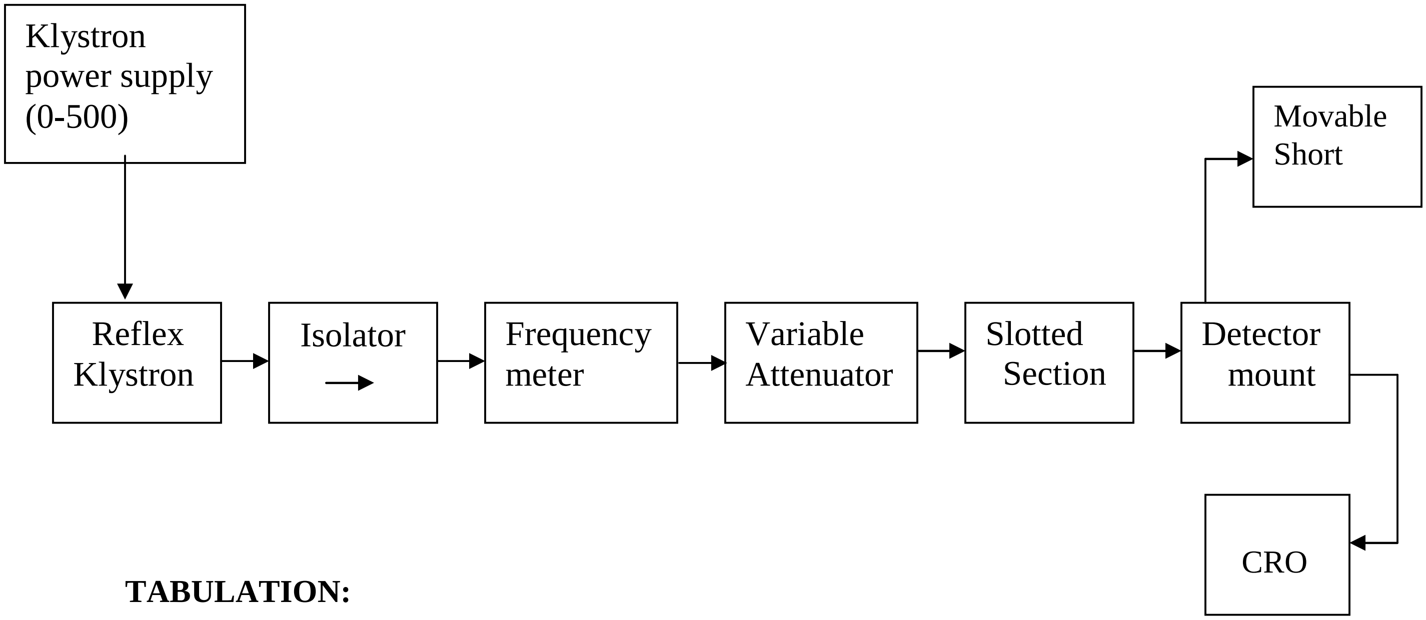
Thus the VI characteristics of the Gunn diode are observed and graph has been plotted.

Negative Resistance R = ------------- Ω

Model Viva Questions:

1. Define T.E.D?
2. Write the features of Gunn diode.?
3. What are the specifications of Gunn diode?
4. Write the applications of Gunn diode.
5. List the advantages of Gunn diode.
6. List the disadvantages of Gunn diode.
7. Give the precaution to be taken while working with Gunn diode?
8. Who is discovered the Gunn diode.
9. Give the definition of Gunn effect in the words of J.B.Gunn?
10. Which type semiconductor material is used for manufacture of Gunn diode?
11. What is –ve resistance region? Give its significance?
12. Name the different modes of oscillation in Gunn diode?
13. What is Quenched mode?
14. What are the requirements for a semiconductor material to make transfer electron effect?
15. In a Gunn diode when applied voltage is greater than threshold formation takes place.
16. The field associated with the domain is greater than the other regions in the specimen. Justify?
17. What is two valley theory?
18. Name other devices which exhibit –ve resistance property?
19. What is the difference between +ve resistance & –ve resistance devices?
20. Give the application of Gunn diodes in electronic steering antennas?

EXPERIMENTAL SET UP:



TABULATION:

S. No	Position	D_1 cm	D_2 cm	$D_1 \sim D_2$ cm	$\lambda_g = 2(D_1 \sim D_2)$	$f = C\sqrt{(1/\lambda_g)^2 + (1/4a^2)}$
					Total	
					Average	

Calculation:

$$f = C\sqrt{(1/\lambda_g)^2 + (1/4a^2)} \quad \text{GHz}$$

Ex. No: 4 MEASUREMENT OF FREQUENCY AND WAVELENGTH

AIM:

To determine the frequency and wavelength in a rectangular waveguide working on TE_{10} model

APPARATUS REQUIRED:

1. Klystron power supply,
2. Reflex klystron
3. Isolator,
4. Frequency meter,
5. Variable attenuator,
6. Slotted section,
7. VSWR meter,
8. Detector mount
9. CRO.

PROCEDURE:

1. Set up the components and equipments as shown in figure.
2. Set up variable attenuator at minimum attenuation position.
3. Keep the control knobs of klystron power supply as below:
   Beam voltage – OFF
   Mod-switch – AM
   Beam voltage knob – Fully anti clock wise
   Repeller voltage – Fully clock wise
   AM – Amplitude knob – Around fully clock wise
   AM – Frequency knob – Around mid position
4. Switch 'ON' the klystron power supply, CRO and cooling fan switch.
5. Switch 'ON' the beam voltage switch and set beam voltage at 300V with help of beam voltage knob.
6. Adjust the repeller voltage to get the maximum amplitude in CRO
7. Maximize the amplitude with AM amplitude and frequency control knob of power supply.
8. Tune the plunger of klystron mount for maximum Amplitude.
9. Tune the repeller voltage knob for maximum Amplitude.
10. Make the probe to be at rest at the starting edge of the slotted section.
11. Move the probe along the slotted section.
12. Tune the probe for maximum output and note down the vernier scale reading along with the least count value..
13. Similarly by tuning the probe, locate and calculate the alternate minima and maxima values of output.
14. With the help of D1 and D2 values calculate the guide wavelength.

$$\lambda_g = 2\ (D1 \sim D2)$$

15. By using resulted guide wavelength λ_g , the required frequency is calculated.

$$f = C\sqrt{(1/\lambda_g)^2 + (1/4a^2)} \quad GHz$$

16.Calculate the difference between two maximas or two minimas, which gives $\lambda_g/2$.

Where, a is the inner broad wall dimension

$a = 2.3$ cm

$C = 3 \times 10^8$ m/s

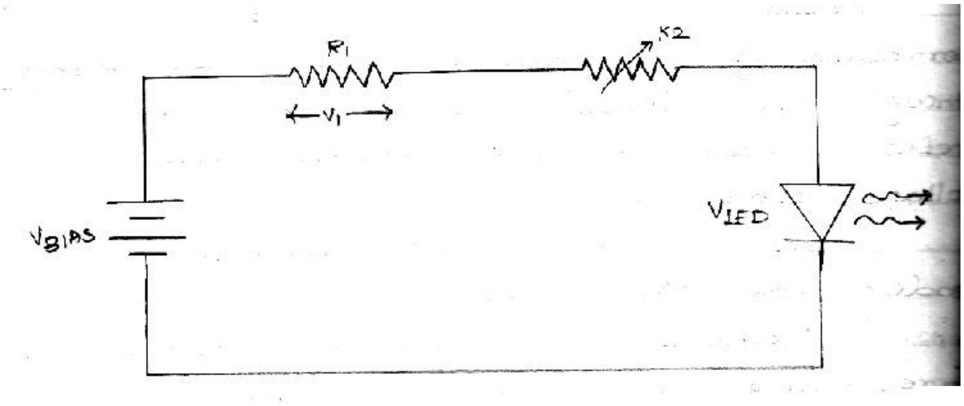
Result:

Thus the frequency and wavelength on the rectangular waveguide is determined.

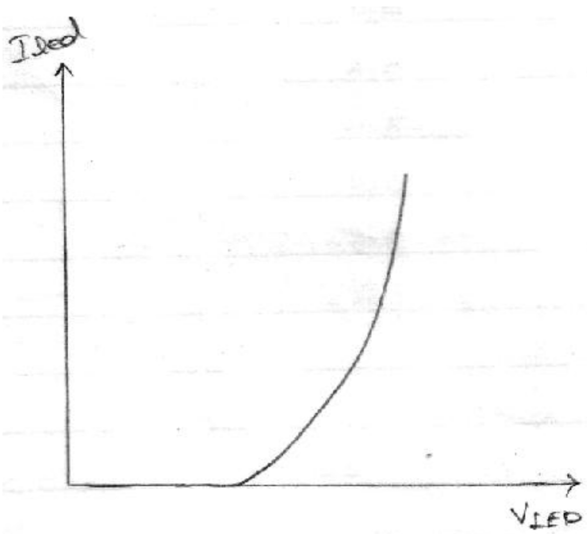
f = GHz

Circuit Diagram:

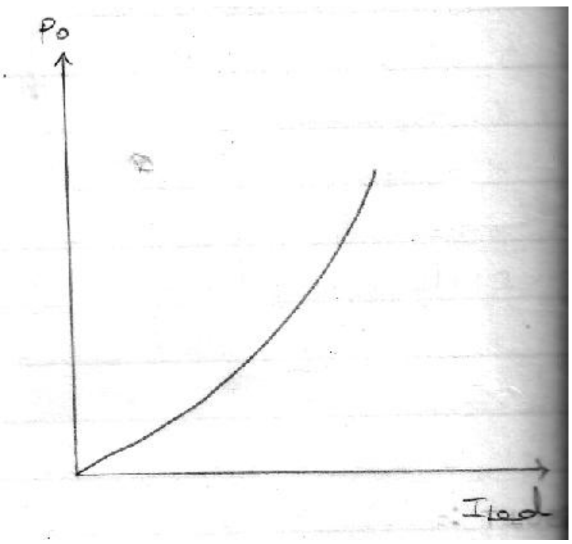
R_1 R_2



MODEL GRAPH:



(i) V-I Characteristics of LED



(ii) P-I Characteristics of LED

Ex. No: 5

STUDY OF CHARACTERISTICS OF LED

AIM:

To study the I-V characteristics of LED and plot the graph of forward current v/s output optical energy

Apparatus Required:

1. LED module (850nm)
2. OFT power supply
3. optic power meter
4. Multimeter
5. Bare fiber adaptor
6. Plastic fiber (850 nm)

NOTE: KEEP ALL SWITCH FAULTS IN OFF POSITION.

PROCEDURE:

1. Connect the OFT power supply to the module using DIN-DIN cable. Mount the bare fiber adaptor on the PD of the power meter.
2. Connect the bare fiber between the LED module and the power meter.
3. Measure the resistance R1.
4. Turn the multi-turn port in the LED module to its minimum position and switch on the module.
5. Note the value of V1, V_{LED} and power(dBm).
6. Turn the potentiometer clockwise at period ic steps of V1 measure V_{LED} and tabulate.
7. Determine the power using the formula

   $P(dBm) = 10\log(P_0 / 1mw)$

   $P_0 = \text{antilog}(P(dBm)/10) \times 1mw$

8. Calculate I_{LED}, using $I_{LED} = V_1/R_1$
9. Plot the curves for V_{LED} vs I_{LED} and P_0 vs I_{LED}
10. Determine $V_{cut\ in}$, forward resistance and conversion efficiency.

PRECAUTIONS:

1. Avoid loose connections.
2. Avoid Parallax errors.

OBSERVATION TABLE:

R1=180 Ohms for 850nm

S.No	V_1 (volts)	V_{LED} (Volts)	I_{LED} (mA)	P (dBm)	P_0(mW)

Calculations:

$P(dBm) = 10\log (P_0 / 1mw)$

$P_0 = \text{antilog} (P(dBm) /10) \text{ X } 1mw$

$I_{LED} = V_1/R_1$

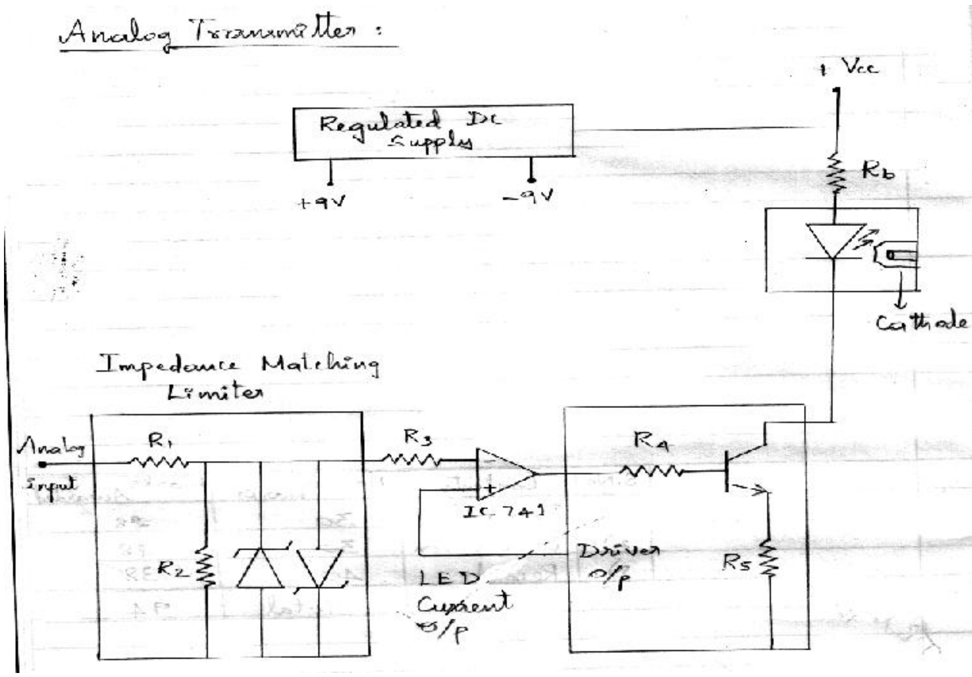
Results:

The VI characteristics of fiber optic LED are observed and ploted.

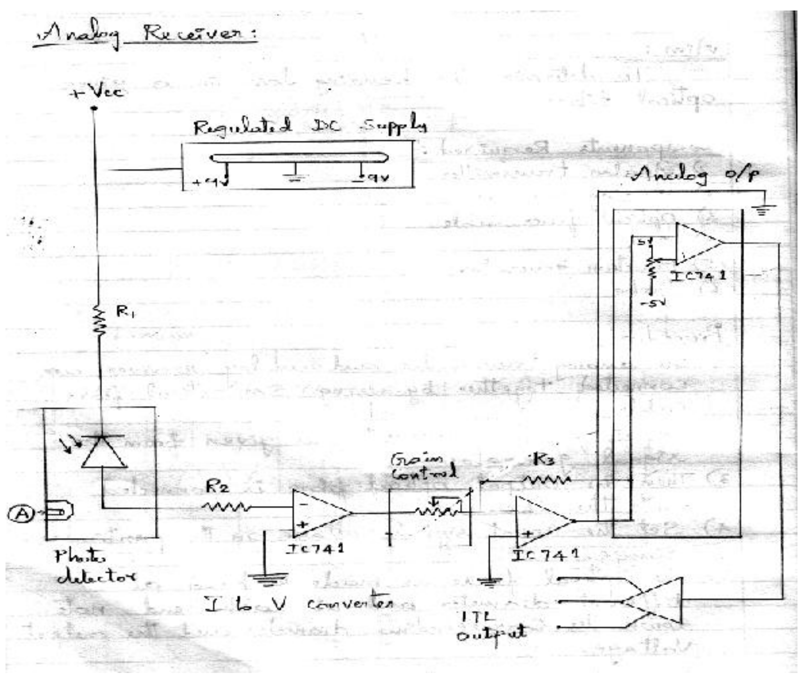
Model Viva Questions:

1. What is the basic principle of LED?
2. LED is coherent or non-coherent? Explain.
3. Which type of materials are used for the manufacture of LEDs?
4. What is the difference between LED and Laser?
5. What is the frequency and wavelength of the LED used in your experiment?
6. Define threshold voltage for LED?
7. Give the applications and advantages of LED?
8. Give the significance of optical communication by comparing RF communication?

Circuit Diagram: Analog Transmitter:



Analog Receiver:



Ex.No:6 ATTENUATION MEASUREMENT IN OPTICAL FIBER

AIM:

To determine the attenuation loss in the given optical fiber.

APPARATUS REQUIRED:

1. optical fiber trainer
2. CRO
3. Function generator
4. Optical fiber
5. Probe

PROCEDURE:

1. Set the interfaces as given in the table.
2. Set the switch SWS to the Analog position.
3. Connect a 1M fiber to LED1 in the TX1 block and the detector Pb1 in the RX1 block.
4. For a given $1V_{PP}$ at input, note the output peak values on a CRO.
5. Now replace the fiber with a 3m fiber and the output peak voltage as V3.

$$\frac{P_3}{P_1} = \frac{V_3}{V_1} = e^{-\alpha(L3 - L1)}$$

L3 = 3m

L1 = 1m

6. Determine the attenuation α in nepers

α (dB/m) = 4.34 α

Where α is in nepers/m

RESULT:

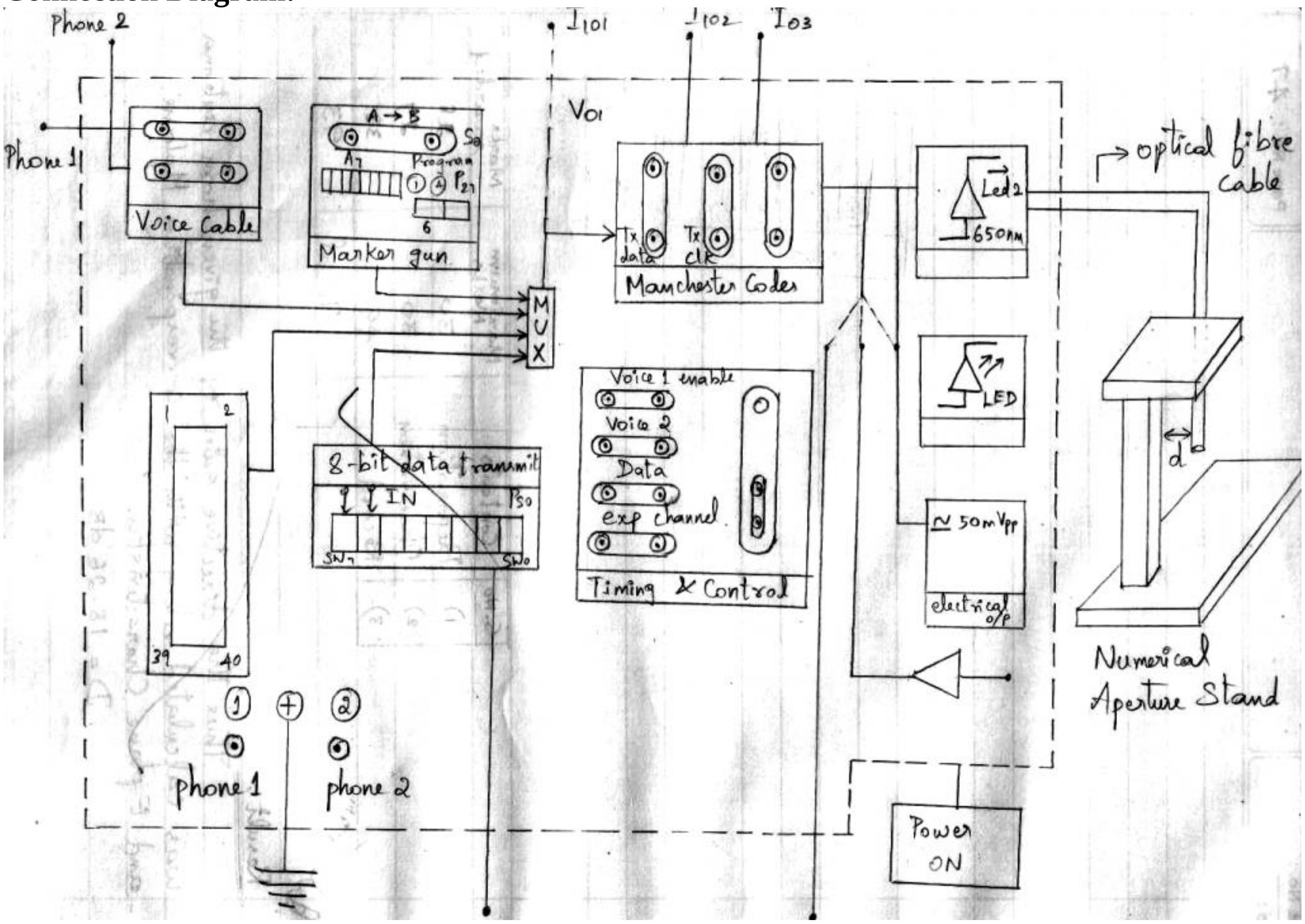
Thus the attenuation loss for the given optical fiber cable was calculated.

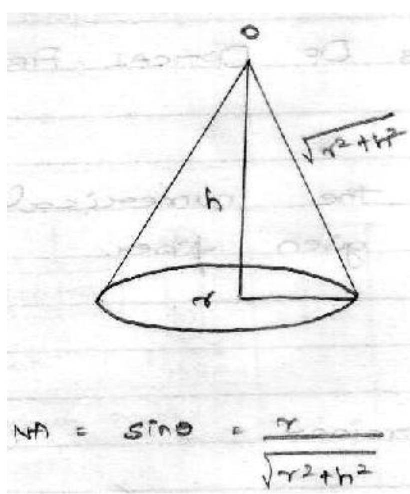
$\alpha =$ dBm

Model Viva Questions:

1. What are various losses in optical fibers?
2. In which type of fiber bending losses are more?
3. In which type of fibers, bending losses are very poor?
4. In which situation optical fiber subject to bend?
5. Why bending losses is negligible in multi mode fiber
6. How radiation intensity decreases in a optical fiber when it is subjected to bend
7. Which parameter undergo change when optical fiber is subjected to bend
8. What are bending losses?
9. How attenuation depends in an optical fiber?
10. What are the limitations of optical fibers in long distance communications

Connection Diagram:





Ex.No. 7 **NUMERICAL APERTURE OF OPTICAL FIBER**

AIM:

To determine the numerical aperture of a given fiber.

Apparatus Required:

1. OFT-2 Channel
2. CRO
3. Optical fiber cable
4. Numerical Aperture Stand

Procedure:

1) Set the interfaces as given in above table
2) Set the switch SWS to the ANALOG position
3) Insert one end of the giber into the Numerical Aperture Stand and the other to the optical source.
4) Adjust the fiber at a certain distance from the screen and tighten it.
5) Observe the circular patch of red light on the screen and measure the diameter of the patch and height of the fiber.
6) Determine Numerical Aperture for various values of "h" and find the average value.

$$NA = \frac{r}{\sqrt{r_2 + h_2}}$$

Tabulation:

Height (h) cm	Diameter in cm (α)	Radius in cm (r)	$NA = \frac{r}{\sqrt{r^2 + h^2}}$
		Total	
		Average	

Interface Details for Experiment:

S.No	Identification Name	Function	Location
1.	SW8	Analog / Digital selection switch should be set to ANALOG position	
2.	LED1 850nm	850nm LED	Optical TX1 block
3.	LED2 650nm	650nm LED	Optical TX2 block
4.	PD1	PIN Detector	Optical RX1 block
5.	JP2	PD1/PD2 receiver select posts B & A1 should be shorted	
6.	Gain	Gain control potentiometer	Optical RX1 block
7.	P11 ANALOG IN	Analog IN	
8.	P31	PIN Detector signal after gain	Optical RX1 block
9.	I/01, I/01, I/03	Input / Output BNCs and posts for feeding in and observing signals	
10.	S6 coded data	Manchester Coded Data shorter link. Post A: Coded output Post B: Input to TX1 / TX2 / Bectrical posts A & B should be shorted.	Manchester Coder Block

11.	S26 Coded data	Received Manchester coded data shorting link Post A: Receiver output (RX1/RX2) Post B: Input to decoder and clock recovery block Posts A and B should be shorted	Decoder and clock recovery block

Result:

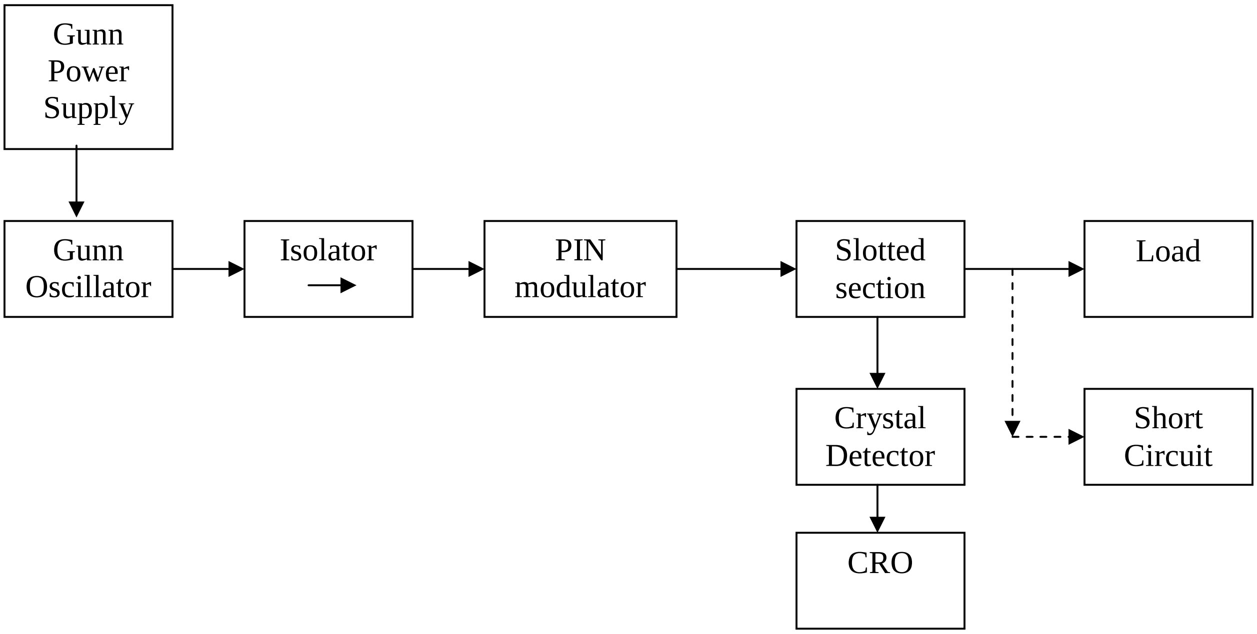
Thus the numerical aperture of the fiber have been determined.

NA =

MODEL VIVA QUESTION:

1. What are various losses in optical fibers?
2. In which type of fiber bending losses are more?
3. In which type of fibers, bending losses are very poor?
4. In which situation optical fiber subject to bend?
5. Why bending losses is negligible in multi mode fiber
6. How radiation intensity decreases in a optical fiber when it is subjected to bend
7. Which parameter undergo change when optical fiber is subjected to bend
8. How attenuation depends in an optical fiber?
9. What are the limitations of optical fibers in long distance communications
10. What is Numerical Aperture?

EXPERIMENTAL SET UP:



Tabulation:

S. No	Load	VSWR	D (cm)	d1 (cm)	d2 (cm)	$\lambda_g = 2(d_2 \sim d_1)$ (cm)	$(D-d_1)/\lambda_g$ (cm)
1)	Horn Antenna			-	-	-	∞
2)	Short Circuit	-	-				

Ex.No: 8 **MEASUREMENT OF IMPEDANCE**

AIM:

To measure the impedance of the given load.

Apparatus Required:

1) Gunn Power Supply
2) Gunn oscillator
3) Isolator
4) Pin modulator
5) Slotted Section
6) Crystal Detector
7) CRO
8) Load and Short circuit

Procedure:

1) Arrange the circuits as shown in the block diagram
2) Set the voltage value of Gunn power supply above 5V and connect the load as horn antenna.
3) Note down the D value for the primary V_{min} of the output signal.
4) Besides calculate the VSWR with the noted V_{max} and V_{min} of the Horn antenna.
5) Replace the Horn antenna with short circuit
6) Measure the distances d_1 and d_2 for the alternative maximum amplitude of short circuit output.
7) Calculate λ_g and the condition for measurement of impedance is $(D-d_1) < \lambda_g /4$
8) Unknown impedance is measured using smith chart

   Draw a line from centre to $(D-d_1)/ \lambda_g$

Observation:

V_{max} for the Horn antenna load, V_{max} = mv

V_{min} for the Horn antenna load, V_{min} = mv

$$VSWR = \frac{V_{max}}{V_{min}}$$

From the smith Chart:

Z_{in} = + j

$Z_o = 377Z_{in}$

Z_0 = +j (load impedance)

Result:

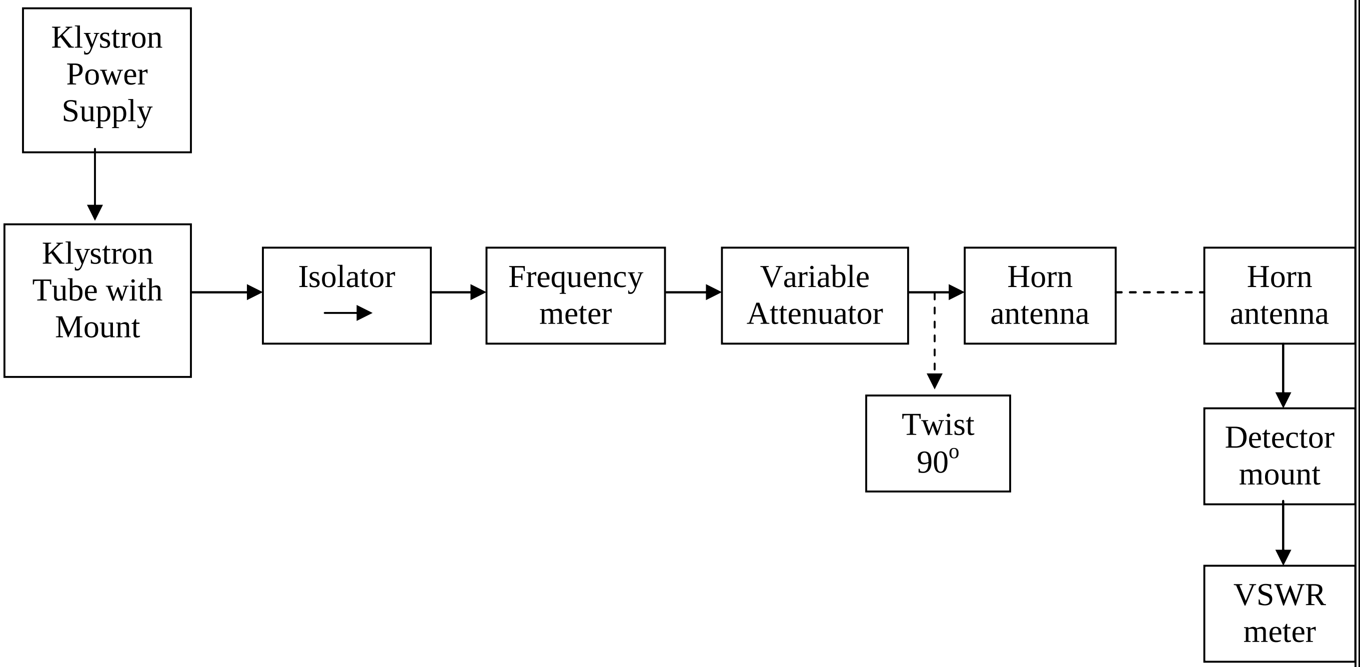
Thus the impedance of the given load was measured using smith chart.

$Z_0 = \quad +j \quad \Omega$

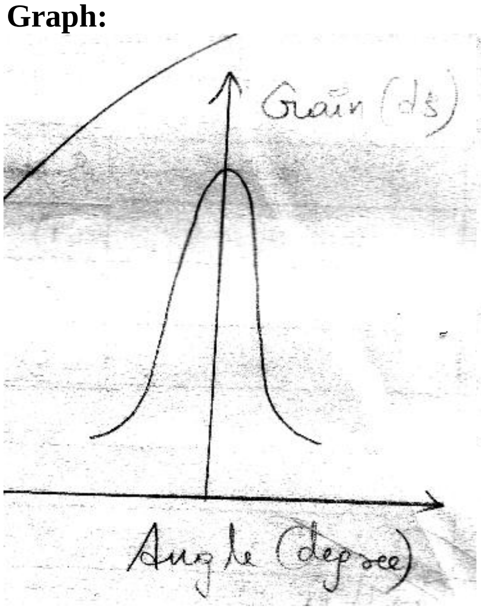
Model Viva Questions:

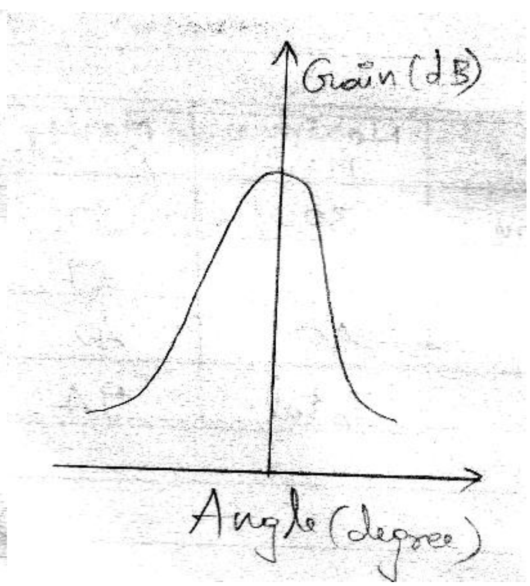
1. Define microwaves?
2. Give the characteristics of microwaves?
3. What are the advantages of microwaves?
4. Give various microwave frequency bands?
5. List the applications of microwaves?
6. What are the various parameters of microwave?
7. If the impedance has +ve phase that indicates……?
8. If the impedance has -ve phase that indicates……?
9. What is the impedance offered by free space for the propagation of EM Wave?
10. Give the relation for intrinsic impedance in terms of E and H?
11. Define characteristic impedance?
12. If the load impedance is not equal to characteristic impedance, what happens in the transmission line?
13. Why impedance is complex ?
14. Non ideal directional couplers and detectors are sources of error. Justify the statement?
15. Explain the principal of reflectometer?
16. Why the amplitude of the signal decreases ,when slot section output terminal is open
17. What is the importance of impedance matching in microwave circuits?
18. What is the need for optimum design of horn?
19. How impedance matching can be achieved between feed element and feed transmission line
20. In a slot section over how much interval series of minimas / maximas occurs?

EXPERIMENTAL SET UP:



Model Graph:





Ex.No: 9 MEASUREMENT OF DIRECTIVITY AND RADIATION PATTERN OF HORN ANTENNA

Aim:

To measure the directive gain of the horn antenna.

Apparatus Required:

1. Klystron power supply
2. Klystron tube with mount
3. Isolator
4. Frequency meter
5. Variable attenuator
6. Detector mount
7. VSWR meter
8. Horn antenna
9. Wave guide

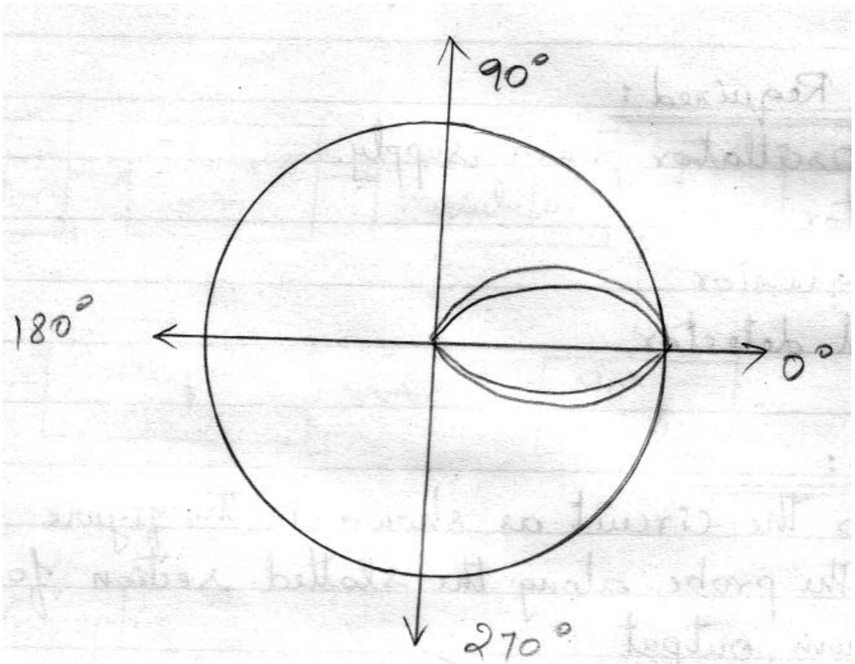
Procedure:

1. Setup the Equipment as shown in the figure keeping the axis of both the antennas in the same line.
2. Energize the klystron or Gunn power supply for maximum output at desired frequency with square wave modulation.
3. Obtain full scale deflection (0 dB) on normal dB scale at any convenient range switch position on VSWR meter by adjusting gain control knob of VSWR meter or by variable attenuator.
4. Tune the receiving horn antenna to left in 2^{o} or 5^{o} left steps and note down the corresponding VSWR dB reading in normal dB range.
5. Repeat the above steps by tuning the receiving antenna to the right in steps of $2^{o} – 5^{o}$ and note down corresponding VSWR value.
6. Plot the readings power VS angle.
7. From the plot determines the 3dB width of the horn antenna.
8. Repeat the procedure, for H-plane characteristics use 90 degree waveguide Twist for transmitter antenna.
9. Find the directive gain of horn antenna using the formula,

$$D = \frac{41325}{4 \times \text{3db angle of E-plane} \times \text{3db angle of H-plane}}$$

In decibel,

D in db = 10 log D db



Tabulation:

V_{in}= V_{in}=

Angular position (in degrees)	E-Plane		H-Plane	
	Output voltage V_0 (V)	Gain= 20 log(V_0/V_{in}) dB	Output voltage V_0 (V)	Gain= 20 log(V_0/V_{in}) dB

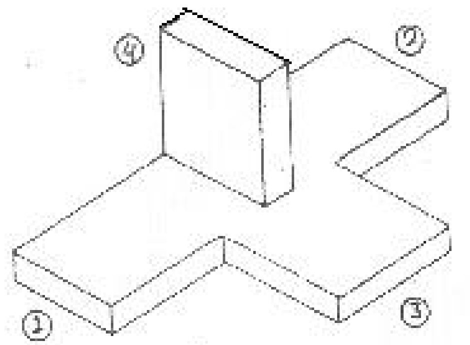
Result:

Thus the directivity is measured for the given horn antenna.

Directive Gain =

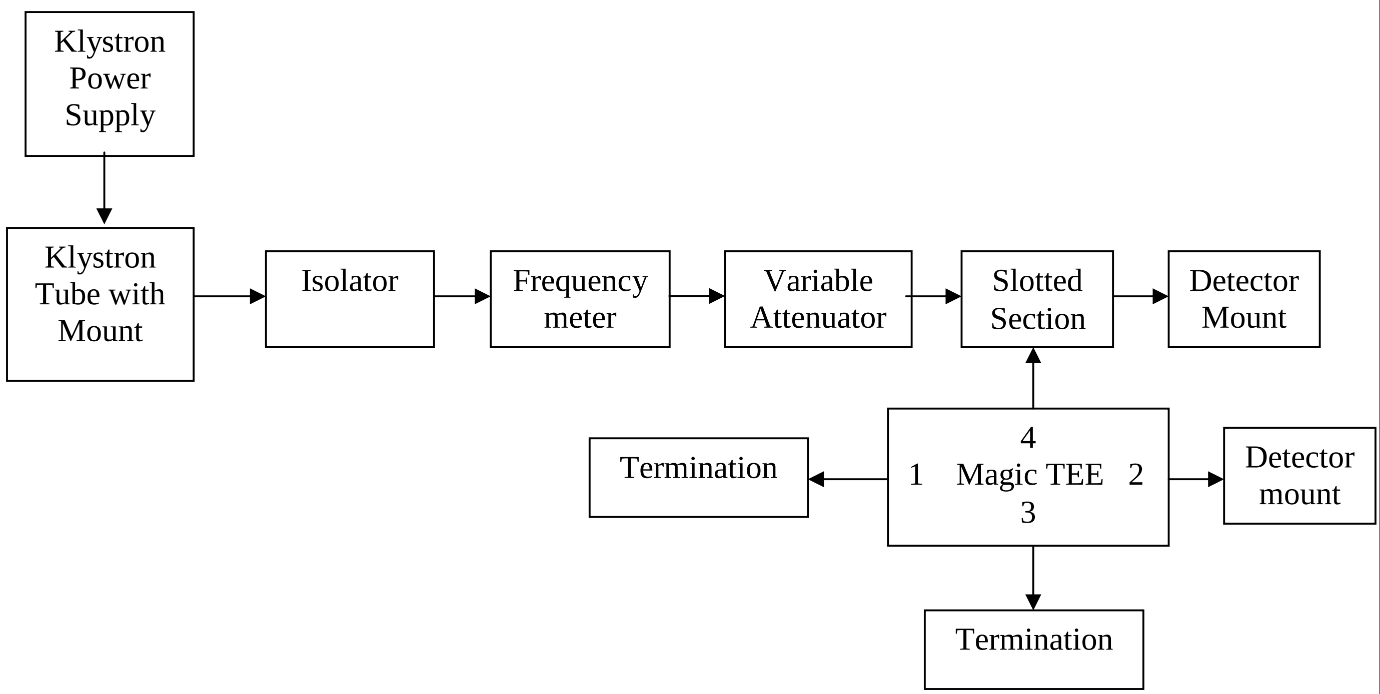
Model Viva Questions:

1. List the applications of horn antenna
2. Write the salient feature of horn antenna?
3. List the types of horn antenna
4. Give the radiation resistance of short monopole horn antenna
5. Write the relation for radiation resistance of short dipole
6. What is power pattern?
7. What is field pattern?
8. What is the difference between polar plot and rectangular plot?
9. What is the difference between isotropic and omni directional pattern?
10. The side lobe level of an antenna is 20dB down. Explain?
11. For a high directional antenna FBR must be……?
12. What antenna reciprocity?
13. Explain the terms bi-directional pattern and uni-directional pattern?
14. In radiation pattern measurement experiment how you increase transmitted peak power using PIN diode
15. What is the relation for patch area illuminated by an antenna in a scan



MAGIC TEE

EXPERIMENTAL SET UP:



TABULATION:

P_1(dB) Power without Magic TEE	**P_2(dB) Power without Magic TEE**	**Isolation $\alpha = P_1 \sim p_2$**	**Coupling Factor $C_{ij} = 10^{-\alpha/20}$dB**

EX.NO:10 **CHARACTERISTICS OF MAGIC TEE**

AIM:

To study the characteristics of magic tee and determine its isolation and coupling factor.

Apparatus Required:

1. Klystron Power Supply
2. Klystron tube with mount
3. Isolator
4. Frequency meter
5. Variable attenuator
6. Detector mount
7. VSWR meter
8. Magic tee
9. Termination
10. Waveguide stand
11. Slotted Section

Procedure:

1. Setup the components as shown in figure
2. Energize the microwave source for particular frequency of operation and tune the detector mount for maximum output.
3. With the help of variable attenuator and gain control knob of VSWR meter and note it down as P_1.
4. Without disturbing the position of variable attenuator and gain control knob carefully place the magic tee after the slotted line keeping H-arm connected to slotted line, E- arm to detector and arm1 and 2 to Matched termination.
5. Note the reading from VSWR meter as P_2.
6. Determine the isolating between port 3 and port 4 as $p_1 – p_2$ in dB.
7. Determine the coupling coefficient as cij = $10^{-\alpha/20}$

   Where $\alpha = 10 \log_{10}(p_2/p_1)$

PRECAUTIONS

1. Keep the cooling fan towards the reflex Klystron.
2. Do not look into the transmitting Horn.
3. Do not apply ever repellar voltages as zero volts.

RESULT:

Thus the characteristics of magic Tee were studied and it's Isolation and coupling factor was calculated.

Model Viva Questions:

1. List the applications magic tee
2. What are the features of magic tee?
3. Write the scattering matrix of magic tee.
4. Write the scattering characteristics of magic tee.
5. What is the magic in a tee junction?
6. Explain felid distribution across the arms of the magic tee?
7. Write the symmetric properties of magic tee
8. H- Plane junction means
9. E- plane junction means
10. If arm 1& arm 2 of magic tee fed with two signals Pi& P , calculate the field strength at arm-3
11. What is folded magic tee?
12. Draw the field distribution in a H-plane tee
13. Draw the field distribution in a E-plane tee
14. Draw the field distribution in a EH-plane tee.
15. Draw the diagram of Magic tee
16. Explain how magic tee works as a power splitter
17. How magic tee can be used as mixer?
18. Why S11 =S22 =S33 =S44 =0 in a magic tee?
19. Why S12 =S21 =0 in a magic tee?
20. How magic tee can be used for impedance measurement

EXPERIMENTAL SET UP:

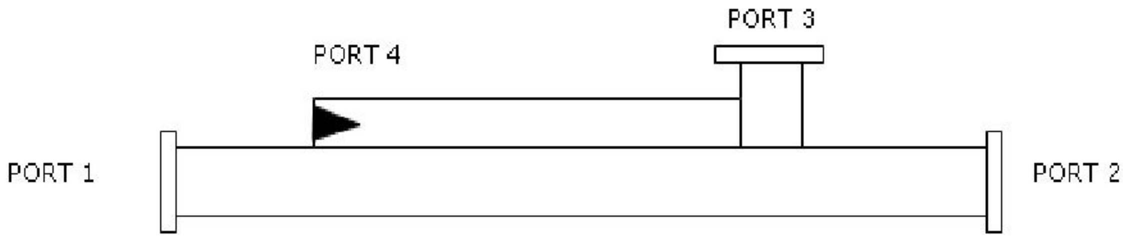
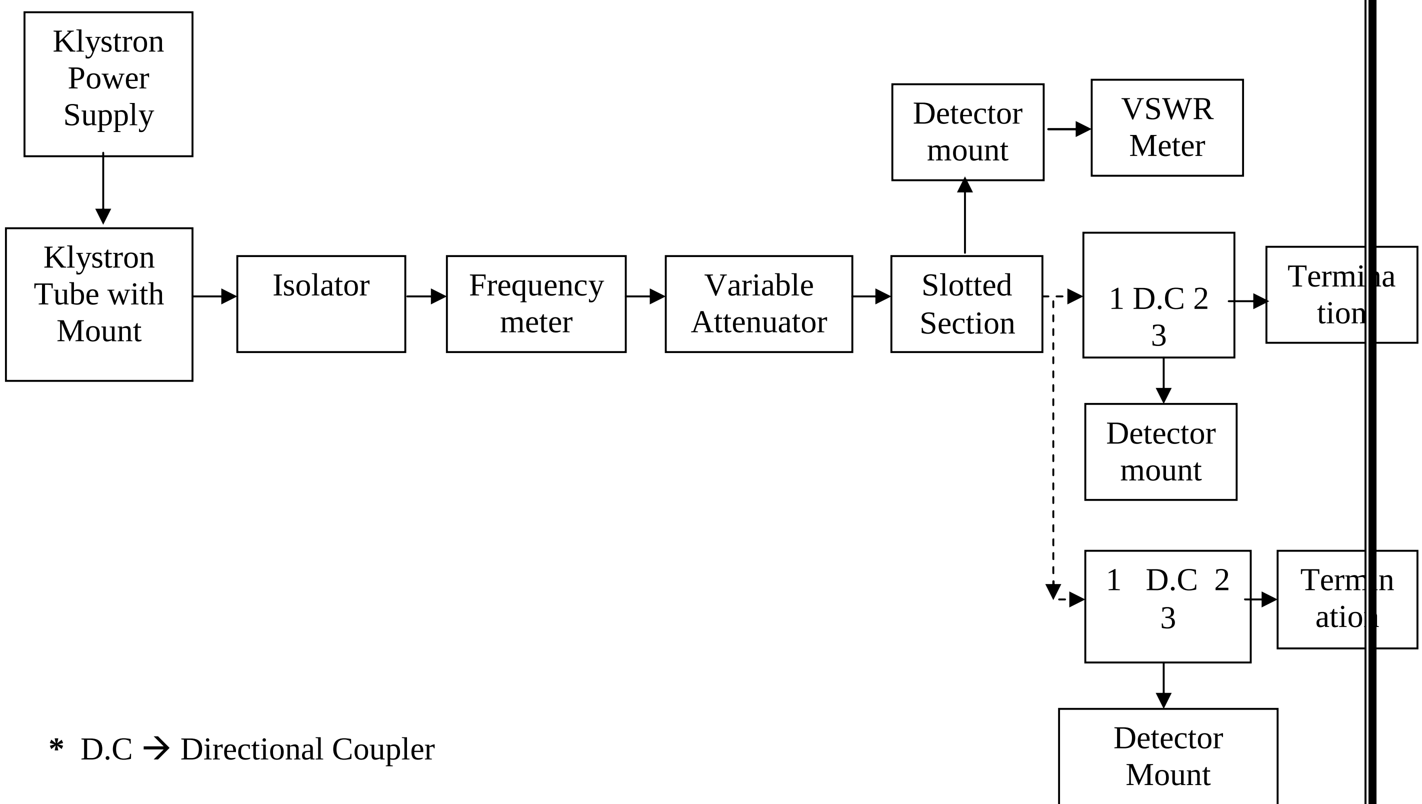


FIG. DIRECTIONAL COUPLER



* D.C → Directional Coupler

EX.NO: 11 STUDY OF DIRECTIONAL COUPLER

AIM:

To study the function of multihole directional coupler by measuring following parameters

1. Mainline and auxiliary line VSWR
2. Coupling factor and directivity of the coupler

APPARATUS REQUIRED:

1. Klystron Power Supply
2. Klystron tube with mount
3. Isolator
4. Frequency meter
5. Variable attenuator
6. Detector mount
7. VSWR Meter
8. Directional coupler
9. Matched termination
10. Wave guide stand

Observation:

1. Reference power level before inserting Directional coupler (X) dB
2. Power level after inserting Directional coupler (Y) dB
3. Power level after Directional coupler Reversed (Yd) dB
4. Power level with Port 3 Matched and Port 2 to Detector(Z)

Coupling factor (C) = X - Y
Insertion Loss (I) = X - Z
Isolation (Is) = X – Yd
Directivity = Y- Yd = Is – C

Procedure:

1. Setup the components as shown in the fig.
2. Energize the Klystron or Gunn power supply for maximum output at desired frequency with square wave modulation
3. Set any reference level of power on VSWR meter with the help of variable attenuator Gain control Knob of VSWR meter and note the reading (X)
4. Insert the directional coupler, with detector to Auxiliary port3 and Matched termination to port2 without changing the position of variable attenuator and gain control knob of VSWR meter
5. Note down the reading on VSWR meter on the scale with the help of range dB switch if required (Y).
6. Calculate coupling factor C= X – Y in dB
7. Now carefully disconnect the detector from the Auxiliary port 3 and Matched termination from port2 without disturbing the setup.
8. Connect the matched termination to the Auxiliary port 3 and detector to port 2 and measure the reading on VSWR meter (Z)
9. Compare insertion loss I = X – Z in dB.
10. Connect the directional coupler in reverse direction i.e port2 to frequency meter side, Matched termination to port 1 and detector mount to port 3, without disturbing the position of the variable attenuator and gain control Knob of VSWR meter.
11. Measure and Note the reading on VSWR meter (Yd). Isolation (Is = X – Yd) in dB
12. Compute the directivity as Y – Yd = Is - C

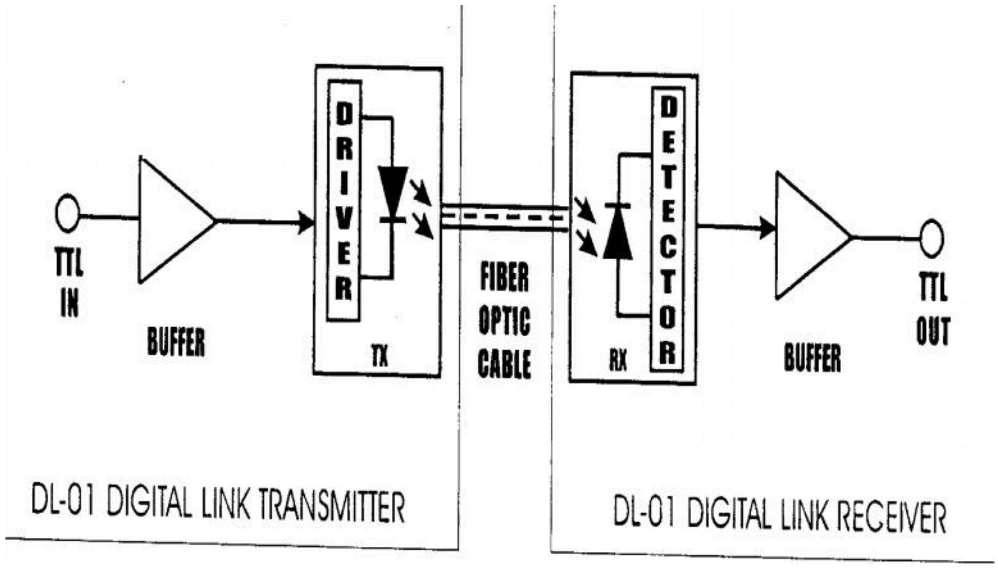
Result:

Thus the characteristics of multiple directional coupler was studied and its insertion loss, coupling factor, isolation loss and directivity were calculated.

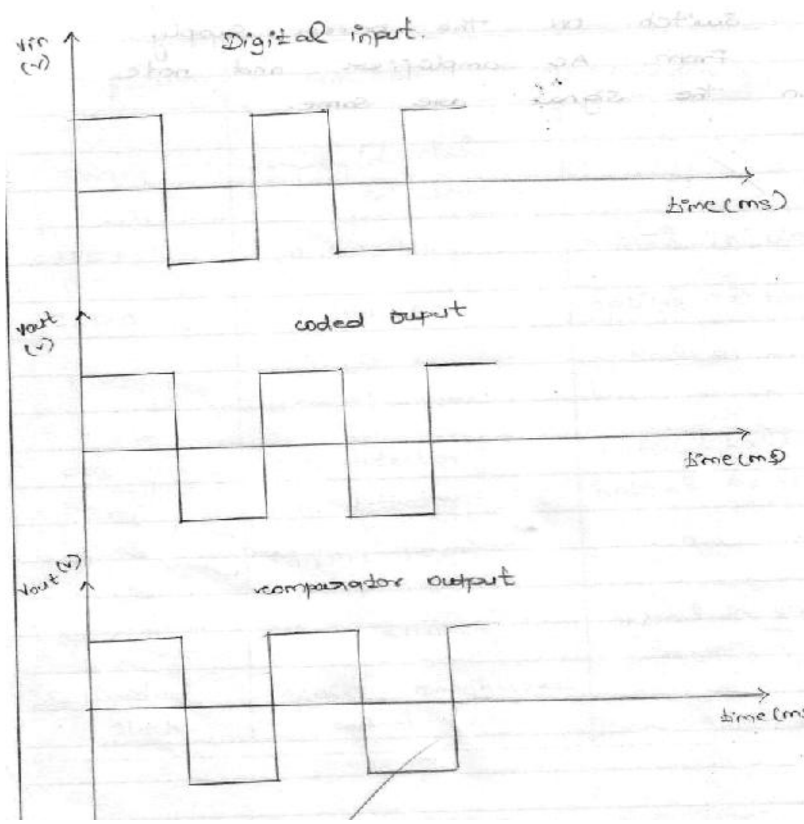
Model Viva Question:

1. What is the significance of directional coupler?
2. Define coupling factor?
3. Define directivity?
4. Define transmissions loss?
5. Define reflection loss?
6. List the applications of directional couplers?
7. Write the scattering matrix of ideal directional coupler?
8. Which type of directional coupler is used in this laboratory?
9. The microwave directional coupler is a device that sample part of…………….
10. If the coupling factor is not sufficient, how can you increase the power handling?
11. Capability of your power meter?
12. Give the directivity an ideal directional coupler?
13. Name the various types of directional couplers?
14. Draw the neat diagram of bifurcated directional coupler.
15. In an ideal directional coupler the back power is …….?
16. What is the difference between single hole directional coupler and multi hole directional coupler?
17. Why the fourth port of the directional coupler used in this laboratory is matched terminated?
18. Directional coupler is reciprocal / non reciprocal ?
19. Directional coupler is active / passive?
20. Among directional coupler , Magic Tee, E-plane Tee, H-plane Tee, rat race junction and attenuator which one can be used for power measurement ?Explain

EXPERIMENTAL SET UP:



Model Graph:



Ex. No: 12 **DATA TRANSMISSION THROUGH FIBER OPTIC LINK**

Aim:

To study on setup 650nm and 850nm digital links and to measure the maximum bit rates.

Apparatus Required:

1. OFT
2. Two channel 20MHZ oscilloscope
3. Function generator 1Hz to 10 MHZ

Procedure:

1. Connect the power supply to circuit biased.
2. Ensure that all following connections that switch faults are off.
3. By connections, the function generator is of 1kHz of emitter input
4. Detector output to AC amplifier circuit.

Digital mode:

1. Setup the connection as previous switch ON the board.
2. Switch emitter device to switch mode.
3. Switch ON the power supply from AC amplifier and note down the signal are same.

Interface Details for Experiment

S.No	Identification Name	Function	Location
1.	SWS	Analog/digital selection	
2.	LED1	850nm LED	Optical TX1 block
3.	LED2	650nm LED	Optical TX1 block
4.	PD2	Optical receiver with TTL O/P	Optical RX1 block
5.	PD1	Pin detector	Optical RX1 block
6.	P31	Pin detector	Optical RX1 block
7.	Jp2	PD1/PD2 receiver select	
8.	Gain	Gain Control	Optical RX1 block
9.	S6 loaded clock	Receiver Manchester coded	

Tabulation:

TX1 data	RX1 data
10110111	10110111
01010101	01010101
11110101	11110101

Result:

Thus the 85nm and 650nm fiber optic digital links has been studied.

Model Viva Questions:

1. Give the basic structure of fiber optic cable
2. Define single mode and multi mode fibers
3. What is index profile?
4. What are step index and graded index fibers?
5. Draw the index profile for step index fiber?
6. Draw the index profile for graded index fiber?
7. What is the propagation principle in step index fibers?
8. What is the propagation principle in graded index fibers?
9. List the applications of optical fibers?
10. Name few sources of optical radiation?
11. Name few detectors of optical radiation?
12. Give the differences between LED and LASER as sources?
13. Give some precautions for optical devices?
14. Comment on need for modulation in optical communications?
15. Comment on type of modulation in optical communications?
16. Explain the function & principle of photo diodes / photo detector?
17. What is numerical aperture?
18. Give the condition for total internal reflection?
19. Which type materials are used for manufacturing of optical fibers?
20. Comment on the refractive index of core and cladding?

Ex.No: 13

MEASUREMENT OF BER
(Bit error Rate)

Aim:

To determine the Bit Error Rate of the optical fiber.

Apparatus Required:

1. Optical Fiber trainer
2. BER kit
3. CRO
4. Patch cards

Interface details for Equipment:

Identification Name	Function
I/O3	I/O BNC's and post feeding in and observing signal TX frame clk
S25 coded data	Receive code receiver clock of BER
S4 coded data	TX data (A,B) – BER of TD
Delayed TX clock	Delayed T2 Clock
S24 coded data	Receiver data – received data of BER

Procedure:

1. Set the interfaces as given in above table
2. set the switch SWS to the analog position.

Result:

Thus the bit error rate of an optical fiber was determined as.

Bit Error Rate = bps

Ex.No:14 **CHARACTERISTICS OF OPTICAL FIBRE**
(Bending Loss and Coupling Loss)

AIM:

To determine the bending loss and coupling loss in a given optical fiber.

Apparatus Required:

1. optical fiber trainer
2. CRO
3. Function generator
4. Optical fiber
5. Probe

Procedure:

Bending loss,

1. Set the interfaces as given in the table.
2. Set the switch SWS to the Analog position.
3. Connect the 1m fiber between the source of detector.
4. Giving a $1V_{PP}$ sinusoidal signal as input.
5. Measure the output peak-voltage as V_1.
6. Bend the fibre in a lamp and reduce the diameter slowly and note the reduction in output signal.
7. Keep reducing the diameter of loop upto 2 cm.

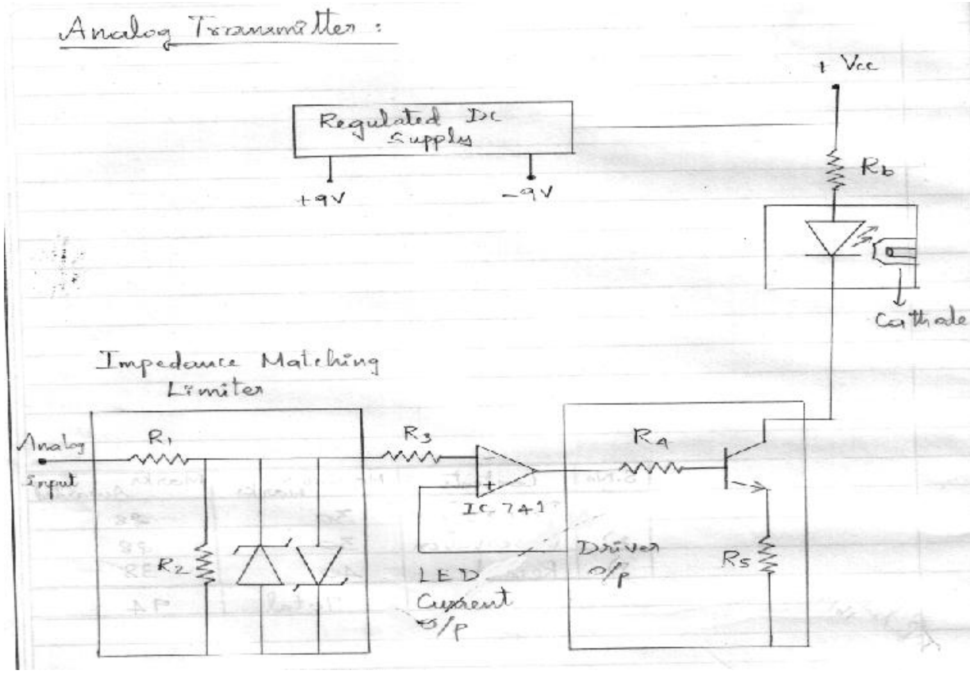
Coupling loss,

1. Set the interfaces as given in the table.
2. Set the switch SWS to the Analog position.
3. Connect the 1m fiber between the source and detector and measure V_1.
4. Now connect a 3m fiber to the detector.
5. Bring the free ends of 1m and 3m fiber together using the fiber aligning unit.
6. Observe the output signal and adjust the distance between the fiber.
7. Calculate coupling loss

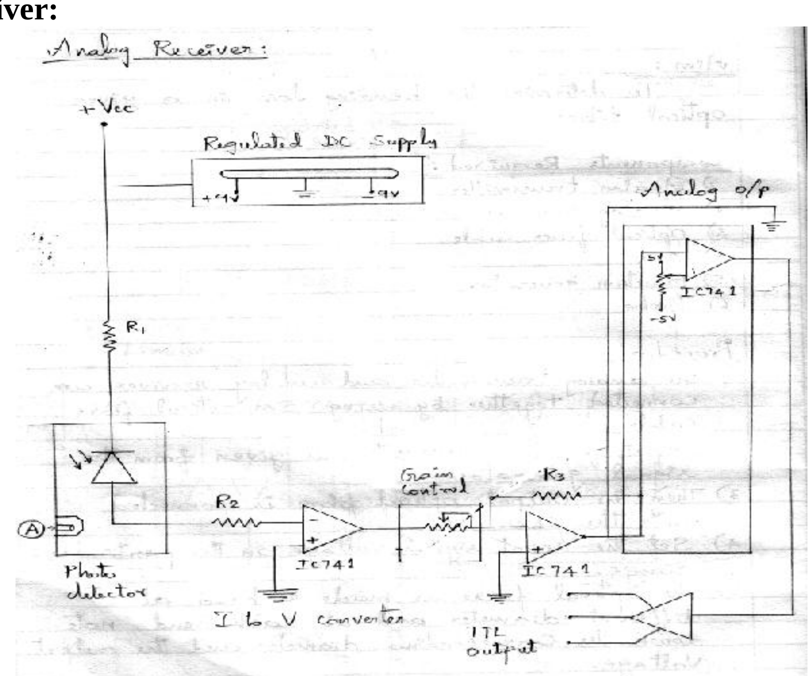
$$ή = -10 \log (V_4/V_1) - \alpha (I_3+I_1)$$

Circuit Diagram:

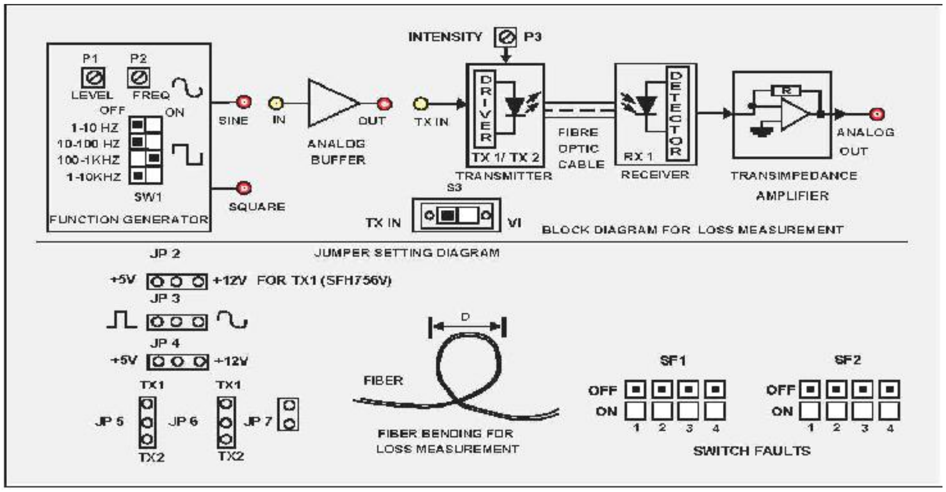
Analog Transmitter:



Analog Receiver:



BLOCK DIAGRAM FOR LOSS MEASUREMENT:



Tabulation:

Bending Loss:

Diameter (cm)	Amplitude (V)

Coupling Loss:

PRECAUTIONS

It is very important that the optical sources be properly aligned with the cable and the distance from the launched point and the cable be properly selected to ensure that the maximum amount of optical power is transferred to the cable.

Result:

Thus the bending loss and Coupling Loss of given optical fibre have been determined.

Coupling factor ή=

Model Viva Questions:

1. What are various losses in optical fibers?
2. In which type of fiber bending losses are more?
3. In which type of fibers, bending losses are very poor?
4. In which situation optical fiber subject to bend?
5. Why bending losses is negligible in multi mode fiber
6. How radiation intensity decreases in a optical fiber when it is subjected to bend
7. Which parameter undergo change when optical fiber is subjected to bend
8. What are bending losses?
9. What is coupling losses?
10. How attenuation depends in an optical fiber?
11. What are the limitations of optical fibers in long distance communications

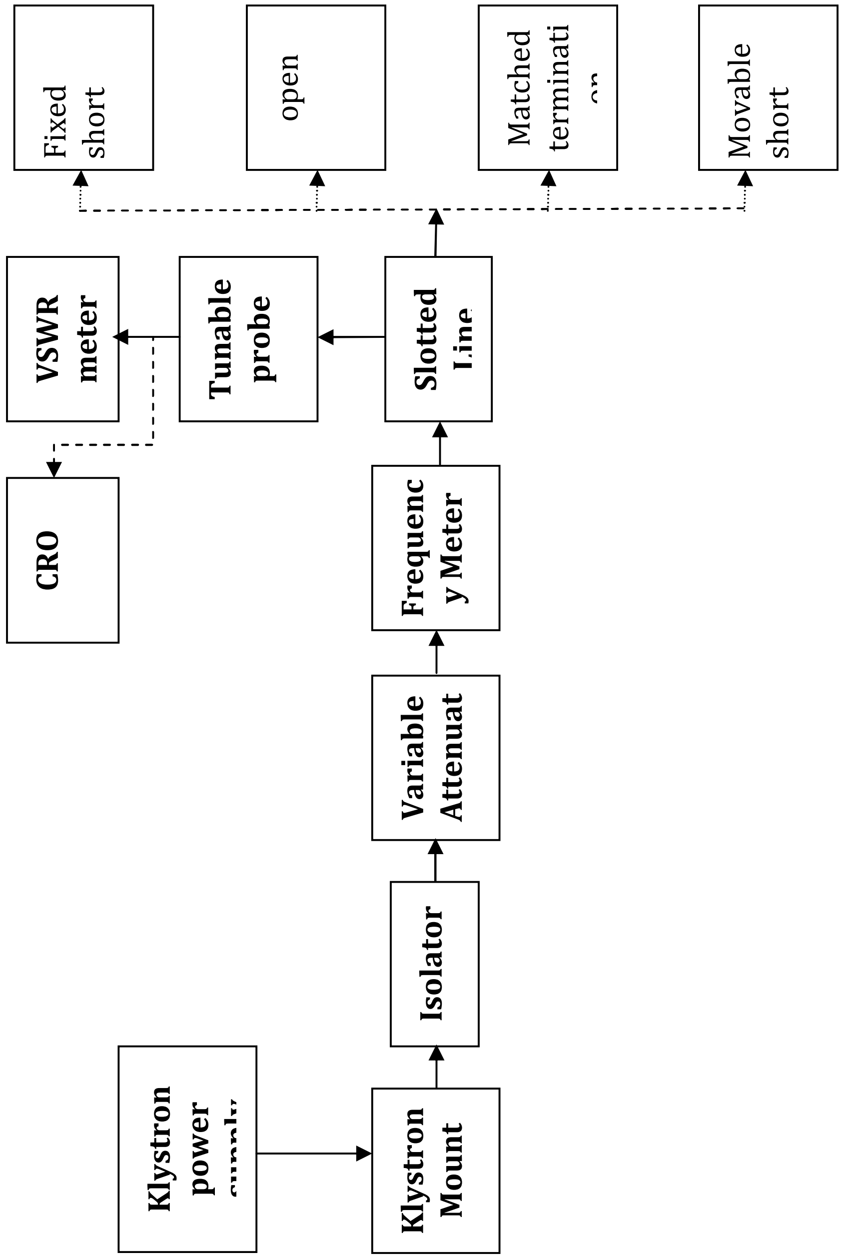


Figure: Bench setup for VSWR measurement

Ex.No. 15 **MEASUREMENT OF VSWR**

AIM:

To Measure the VSWR of fixed short and movable short.

EQUIPMENT REQUIRED

1. Klystron Power Supply,
2. Reflex Klystron Tube with Klystron Mount,
3. Isolator,
4. Frequency Meter,
5. Variable Attenuator,
6. Slotted Line,
7. Tunable Probe,
8. Detector Mount,
9. Wave Guide Stands,
10. VSWR Meter,
11. Oscilloscope,
12. Movable Short /Termination or any unknown load.

PROCEDURE

1. Set up the equipment as shown in the fig.
2. Keep variable attenuator in the minimum attenuation position.
3. Keep the control knobs of VSWR Meter as below
    a. Range db - 40-db/50 db
    b. Input Switch - Low Impedance
    c. Meter Switch - Normal
    d. Gain (Coarse-Fine) - Mid position approx.
4. Keep the Control Knobs of Klystron power supply as below
    a. Beam voltage - OFF
    b. Mod- switch - AM
    c. Beam Voltage knob - fully anticlockwise
    d. Reflector Voltage knob - fully clockwise
    e. AM- Amplitude Knob - around fully clockwise

Tabulation:

Low VSWR:

Load	**V_{max} (v)**	**V_{min}(v)**	**VSWR= V_{max}/V_{min}**
Matched Load			
Horn antenna			

High VSWR:

Load	**D1(cm)**	**D2(cm)**	**d1(cm)**	**d2(cm)**	a_g	**VSWR**
Open Circuit						
Short Circuit						

f. AM- Frequency &
Amplitude knob - Mid position.

5. Switch 'ON' the Klystron power supply, VSWR Meter and Cooling Fan.
6. Switch 'ON' the Beam Voltage Switch position and set beam voltage at 300 V.
7. Rotate the reflector voltage knob to get deflection in VSWR meter.
8. Tune the output by turning the reflector voltage. Amplitude and frequency of AM Modulation.
9. Tune plunger of Klystron Mount and probe for maximum deflection in VSWR meter.
10. If required, change the range db-switch, variable attenuator position and gain control knob to get deflection in the scale of VSWR meter.
11. As you move probe along the slotted line, the deflection will change.

Measurement of Low and Medium VSWR

(a) using VSWR meter

1. Move the probe along the slotted line to get maximum deflection in VSWR Meter.
2. Adjust the VSWR Meter gain control knob or variable attenuator until the meter indicates 1.0 on normal VSWR Scale.
3. Keep all the control knob as it is, move the probe to next minimum position. Read the VSWR on scale.

(B) Using CRO

Connect the detector output to CRO, moving along the slotted line measure V_{max} and V_{min}. Find V_{max} / V_{min}.

Measurement of High VSWR: (Double Minimum Method)

1. Set the depth of S.S. Tuner slightly more for maximum VSWR.
2. Move the probe along with slotted line until a minimum is indicated.
3. Adjust the VSWR meter gain control knob and variable attenuator to obtain a reading of 3 db in the normal dB scale (0 to 10 db) of VSWR Meter.
4. Move the probe to the left on slotted line until full-scale deflection is obtained on 0-10 db scale. Note and record the probe position on slotted line let it be d_1.

5. Repeat the step 3 and then move the probe right along the slotted line until full-scale deflection is obtained on 0-10 db normal db scale. Let it be d_2.
6. Set the movable short to act as a short.
7. Measure the distance between two successive minima positions of the probe. (D_1 AND D_2). Twice this distance is guide wavelength $\lambda_g = 2(D_1 \sim D_2)$.
8. Compute SWR from the following equation:

$$\text{SWR} = \frac{\lambda_g}{\pi (d_1 - d_2)}$$

PRECAUTIONS:

1. Keep the cooling fan towards reflex Klystron.
2. Do not apply ever repellar voltage as zero volts.

RESULT:

Thus the high and low VSWR was measured using double minimum method.