EXP NO 4. GAIN AND RADIATION PATTERN OF HORN ANTENNA

4.1 OBJECTIVE

To obtain Gain and Radiation pattern of a Horn Antenna.

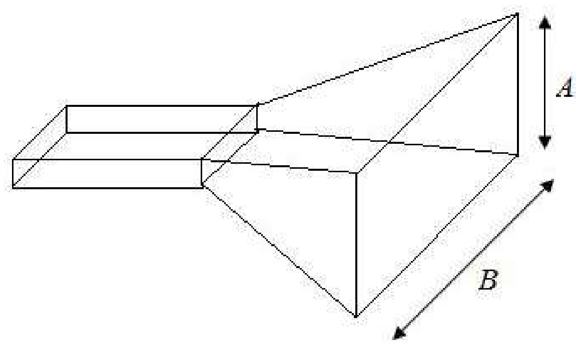
4.2 HARDWARE REQUIRED

Klystron Power Supply, Klystron with mount , Isolator, Frequency meter, Fixed Attenuator Detector, Parabolic Reflector, CRO.

4.3 INTRODUCTION

A horn antenna may be regarded as a flared out or opened out wave guide. A wave guide is capable of radiating radiation into open space provided the same is excited at one end and opened at the other end. However, the radiation is much greater through wave guide than the 2-wire transmission line. To overcome reflection and diffraction in the wave guide, the mouth of the waveguide is opened out which assumes the shape of a electromagnetic horn. If the wave guide is terminated by any type of horn, the abrupt discontinuity existed is replaced by a gradual transformation, then all the energy incident in forward direction in the waveguide will now be radiated, provided the impedance matching is proper. This improves directivity and reduces diffraction. If flaring is done only in one direction, then sectorial horn is produced. If flaring is done along both the walls, then pyramidal horn is obtained. By flaring the walls of the circular waveguide, a conical horn is formed. The fields inside the waveguide propagate in the same manner as in free space, but on reaching the mouth of the waveguide, these propagating fields continue to propagate in the same general direction but also starts spreading laterally and the wave front eventually becomes spherical. However this may be treated as transition region where the change over from the guided propagation to free space propagation occurs. Since the waveguide impedance & free space impedance are not equal, hence to avoid standing wave ratio, flaring of walls of waveguide is done which besides matching of impedance also provide concentrated radiation pattern(ie)greater directivity and narrower beam width. It is the flared structure that is given the name electro magnetic horn radiator. The function is to produce a uniform phase front with a larger aperture in comparison to waveguide and thus directivity is greater. If flare angle is very large, the wave front on the mouth of the horn will be curved rather than plane. This will result in non-uniform phase distribution over the aperture, resulting in increased beam width and reduced directivity, and vice versa occurs if the flare angle is very small. The directivity of the horn antenna is given as $D = 7.5\ A/\lambda^2$ where A is the area of horn mouth opening. Horn antennas are extensively used at microwave frequencies under the condition that power gain needed is moderate.

4.4 PYRAMIDAL HORN ANTENNA



4.5 PRELAB QUESTIONS

1. List some of the types of antennas used in microwaves.
2. Why is a paraboloid preferred to horn at microwave frequencies?
3. Write the formula for directivity & power gain of horn antenna.
4. What are the different types of horn antenna used in microwave frequencies?
5. Comment on the radiation pattern of a practical antenna and a theoretical one.

4.6 PRECAUTIONS

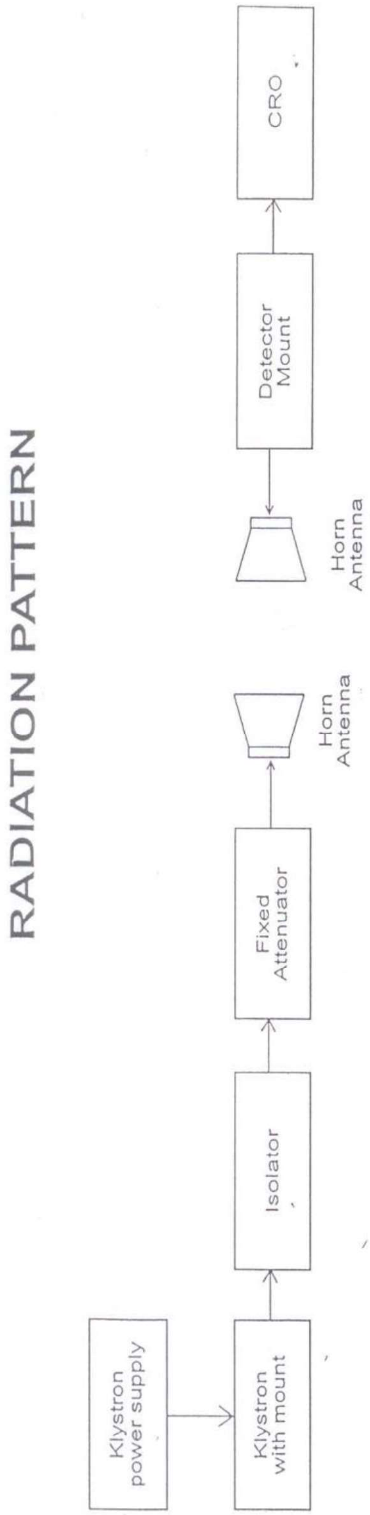
1. Power flowing out of horns may damage retina of the eye so do not see directly inside the horn antenna

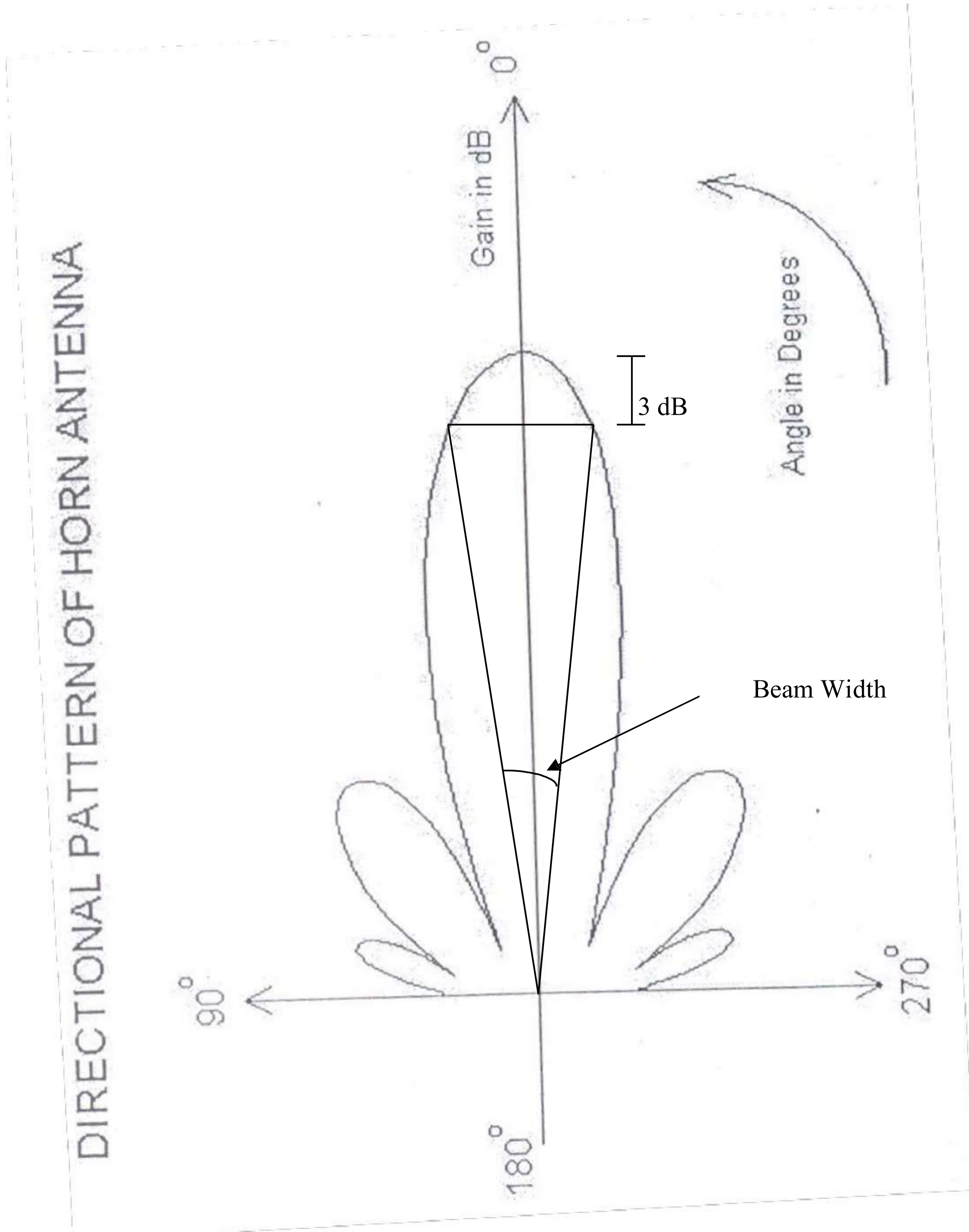
4.7 EXPERIMENT PROCEDURE

1. Setup the equipment as shown in Fig. Keeping the axis of both antennas in same axis line
2. Energize the microwave source, and set mode 3 determine input power at transmitting antenna end by connecting detector mount.

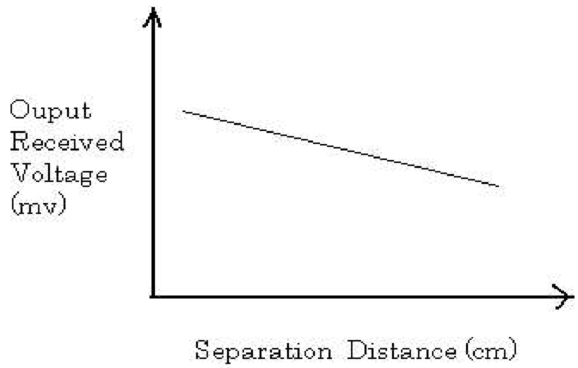
3. Connect the Receiving antenna.
4. Measure the power received at different transmitter-receiver antenna distances.
5. Make a plot of gain pattern with distance of the receiving antenna.
6. Fix the receiver antenna distance at an optimum, turn the receiving horn to the left in 5° steps upto atleast 60° and note the corresponding output voltage.
7. Repeat the above step but this time turning the receiver to the right and note down the readings.
8. Draw a relative power pattern on the polar graph ie, Output power versus reception angle.
9. From the plot obtain the 3 dB beam width.

4.8 BLOCK DIAGRAM




DIRECTIONAL PATTERN OF HORN ANTENNA
Gain in dB
0°
90°
180°
270°
Angle in Degrees
3 dB
Beam Width

4.9 Gain Vs. Separation distance



4.10 TABULATION

INPUT VOLTAGE V_T = _______mv

S. No	Separation Distance (r) (cm)	Output voltage V_R (mV)	Gain (dB) = $10\log(4\pi r/\lambda)+20\log(V_R/V_T)$
1			
2			
3			
4			

Separation distance (r)= ________cm

Angle (degrees)	V_R (mV)		Gain (dB) = $10\log(4\pi r/\lambda)+20\log(V_R/V_T)$	
	Clockwise	Anticlockwise	Clockwise	Anticlockwise
0				
5				
10				
15				
.				
.				
80				
85				
90				

4.11 POST LAB

1. How to find an antenna Beam width?
2. Why measured values of gain and band width do not tally with theoretical values.
3. Why is the maximum signal detected when the transmitting and the receiving units are axially aligned. Explain
4. When a reflectometer is employed in the radiation of signals, how does it affect the VSWR at the transmitter and the receiver.
5. List some important applications of antenna
6. Calculate the near and far field regions of horn antenna for the experimental setup.
7. Consider the transmitting and receiving antenna having the gain of 17dB separated by the distance $R = 2d^2/\lambda$ and the transmitted power P_t = 100mW. Calculate the power received at the distance R and also find the distance at which P_r = 0W.
8. Two lossless X-band horn antennas are separated by a distance of 200λ. The amplitude reflection coefficients at the terminals of the transmitting and receiving antennas are 0.15 and 0.18, respectively. The maximum directivities of the transmitting and receiving antennas (over the isotropic antenna) are 18 dB and 22 dB, respectively. Assume that the input power in the lossless transmission line connected to the antenna is 2 W, and that the antennas are perfectly aligned and polarization matched. Calculate the power (in mW) delivered to the load at the receiver.

4.12 RESULT

Thus, the Gain Vs. separation distance and directional pattern of the given antenna were drawn.