Measurement of Radiation Pattern:

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1. Theoretical Background:

Radiation Pattern: Practical antennas do not radiate uniformly in all directions. The radiation pattern is a graphical representation of the distribution of radiation energy as a function of angle about the antenna in the three-dimensional space and is generally measured in the **far field region**. The strength of radiation is usually measured in terms of field strength relative to some reference level, and this reference level is usually the peak of the main beam. Radiation pattern plots, however, can be shown in terms of field strength, power density or decibels (dB). Thus a complete radiation pattern gives relative field strength (or power radiated) at all angles of 'ɵ' and 'φ' in spherical coordinate system and requires a 3-dimensional presentation. However, in practice, it is common to present cross sections of the radiation pattern in two principal planes of interest. For linearly polarized antennas, these planes are **E- and H-planes**.

Far Field Region: The far field region is defined as that region of space where the angular field distribution of the antenna is essentially independent of the distance from the antenna. If the maximum overall dimension of the antenna is D, then the far field region is commonly taken to exist at distances greater than $2D^2/\lambda$ from the antenna where λ is the wavelength.

E-plane: The E-plane is the plane passing through the antenna in the direction of beam maximum and parallel to the far-field E vector.

H-plane: The H-plane is the plane passing through the antenna in the direction of beam maximum and parallel to the far-field H vector.

Beam Width: The radiation pattern of a typical antenna consists of a main beam and a few minor lobes. Minor lobes usually represent radiation in the undesired directions and they are sensitive to the surroundings in which the radiation pattern is measured. The beam width is a measure of sharpness of the main radiated beam. The 3dB beam width is the angular width of a pattern between the half-power points; that is, 3dB points with respect to the maximum field strength. In the electric field intensity pattern it is the angular width between points that are 1/2 times the maximum intensity.

2. Experimental Procedure:

<u>Block Diagram:</u>

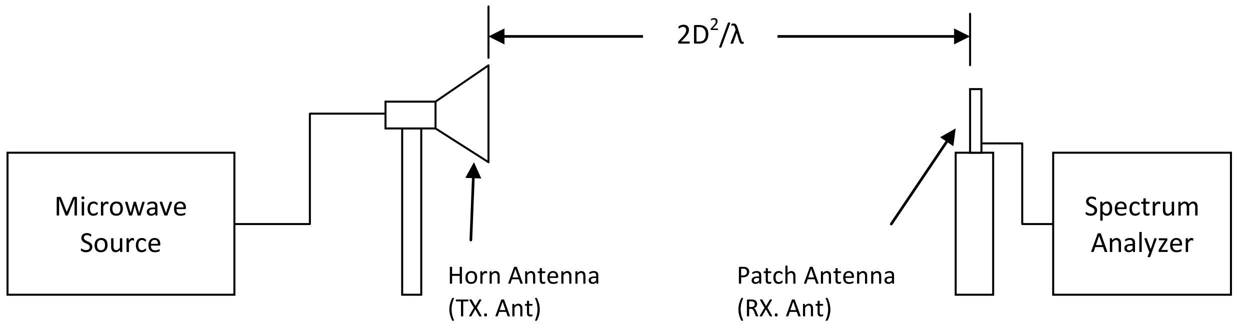

Fig. 1. Antenna radiation pattern measurement set up.

Procedure:

1. Experimental set up is made as shown in Fig 1. Microwave source is connected to the transmitting antenna (Horn Antenna). The antenna under test (patch antenna) is used as a receiving antenna and fixed to the stand whose rotation can be controlled by stepper motor controller. The distance between the horn antenna and patch antenna is kept as $2D^2/\lambda$, where maximum overall dimension of the antenna is D, and λ is the operating wavelength. The patch antenna and horn antenna are placed in line of sight aligned to each other. The receiving antenna is connected to spectrum analyzer (SA) to measure the received power.
2. Patch antenna's resonant frequency is measured from the return loss measurement using vector network analyzer (VNA) .
3. Frequency in the microwave source is set to resonant frequency of the patch antenna and power level is kept at 0 dBm.
4. Set the centre frequency of SA to the operating frequency and span to 1 MHz.
5. Observe the peak reading in the SA consider this reading for 0°.
6. Rotate the receiving antenna stand from 0 to 360 degree on its axis in steps of 10° and note down the power reading from SA. After completing 360° rotate the antenna back to 0°.
7. Repeat the measurement for radiation pattern in another plane (E-plane) by rotating both Tx. and Rx. antenna by 90°.
8. Draw the rectangular radiation pattern for E Plane and H-Plane in the graph sheet.
9. Measure the half power beam width in both the planes $(HPBW)_E$ and $(HPBW)_E$ from the radiation pattern.
10. The directivity (D) of antenna can be find by $D = \frac{4\pi}{(HPBW)_E \times (HPBW)_H}$.

Important Note:-

While taking the reading on vector network analyser (VNA) do the following steps:-

1. For Resonant Frequency measurement connect cable to NA Port (Port 1).
2. For Radiation Pattern measurement connect cable to PA Port (Port 2).

Tabular coloum:

S. No.	Angle	H-Plane	E-Plane
1	10		
2	20		
3	30		
4	40		
5	50		
6	60		
7	70		
8	80		
9	90		
10	100		
11	110		
12	120		
13	130		
14	140		
15	150		
16	160		
17	170		
18	180		
19	190		
20	200		
21	210		
22	220		
23	230		
24	240		
25	250		
26	260		
27	270		
28	280		
29	290		
30	300		
31	310		
32	320		
33	330		
34	340		
35	350		
36	359		