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|  | ***Department of Electronics and Telecommunication Engineering***  ***(NBA ACCREDIATED)***  ***Digital Communication Laboratory***  ***Academic Year 2020-2021***  ***Odd Semester*** |

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| **Course Code** | ECC603 |
| **Subject Professor In-charge** | Prof. Santosh Jagtap |
| **Student Name** | Anuj Shah |
| **Roll Number** | 18104B0024 |
| **Class** | TE |
| **Division** | EXTC B |
| **Date of Performance** | 24-Mar-2021 |
| **Date of Submission** |  |

**EXPERIMENT NO.2**

**Plot far field radiation pattern of Dipole and measure HPBW and Directivity.**

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| **Total**  **(10 Marks)** | **Sign** |
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**EXPERIMENT No.2**

**Title:** Plot far field radiation pattern of Dipole and measure HPBW and Directivity.

**Estimated time to complete this experiment:** 02 hours

**Objective:** Understand radiation pattern of antenna

**CO to be achieved:**

**Expected Outcome of Experiment:** Performance analysis of dipole antenna at different length by using far field parameters.

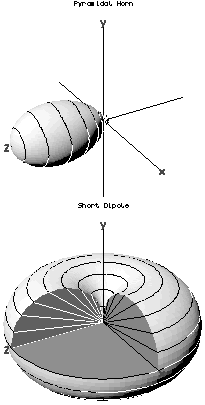
**Pre Lab/ Prior Concepts:** Transmission Line, Electromagnetics

**Theory (2 Marks)**

In the field of antenna design, the term radiation pattern (or antenna pattern or far-field pattern) refers to the *directional* (angular) dependence of the strength of the radio waves from the antenna or other source.

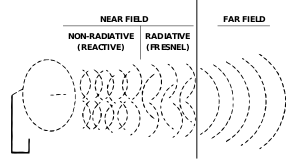
Particularly in the field of fiber optics, lasers and integrated optics, the term radiation pattern may also be used as a synonym for the near-field or Fresnel pattern. This refers to the *positional* dependence of the electromagnetic field in the near field, or Fresnel region of the source. The near-field pattern is most commonly defined over a plane placed in front of the source, or over a cylindrical or spherical surface enclosing it.

The far field radiation pattern may be represented graphically as a plot of one of a number of related variables, including the field strength at a constant (large) radius (an amplitude pattern or field pattern), the power per unit solid angle (power pattern) and the directive gain. Very often, only the relative amplitude is plotted, normalized either to the amplitude on the antenna boresight, or to the total radiated power. The plotted quantity may be shown on a linear scale, or in dB. The plot is typically represented as a three-dimensional graph, or as separate graphs in the vertical and horizontal plane. This is often known as a polar diagram.



The near field and far field are regions of the electromagnetic field (EM) around an object, such as a transmitting antenna, or the result of radiation scattering off an object. Non-radiative ‘near-field’ behaviors dominate close to the antenna or scattering object, while electromagnetic radiation ‘far-field’ behaviors dominate at greater distances.

Far-field E (electric) and B (magnetic) field strength decreases as the distance from the source increases, resulting in an inverse-square law for the radiated *power* intensity of electromagnetic radiation. By contrast, near-field E and B strength decrease more rapidly with distance: the radiative field decreases by the inverse-distance squared, the reactive field by an inverse cubed law, resulting in a diminishing power in the parts of the electric field by an inverse fourth-power and sixth-power, respectively. The rapid drop in power contained in the near-field ensures that effects due to the near-field essentially vanish a few wavelengths from the radiating part of the antenna.



Wikipedia: <https://en.wikipedia.org/wiki/Radiation_pattern>  
Wikipedia: <https://en.wikipedia.org/wiki/Near_and_far_field>

**Simulation Model/ Code (1 Marks)**

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| **Dipole Design** |

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| **Design Specification:**   1. **Frequency (f) :** 80 MHz, 750 MHz, 1GHz 2. **Length of Wire (L) :** 0.5λ, 1λ, 3λ/2, 5λ/2,   **Calculation of Dipole Length:**  Velocity factor=0.95     |  | | --- | | **λ =0.95\*c/f** |     Where,  c=Speed of light  L= Length of dipole |

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| **MATLAB CODE:**  %Define specification  n=377;  Io=1;  r=10;  f=80e6;  lambda=0.95\*3e8/f;  k=(2\*pi)/lambda;  L=2.5\*lambda;  f=0.95\*3e8/lambda;  %Design Antenna  h=dipole('Length',L,'Width',L/10);  %Plot 2D Pattern  theta=0:0.01:2\*pi;  E=j\*n\*Io\*exp(-j\*k\*r)\*(1/(2\*pi\*r))\*((cos(k\*L\*cos(theta)/2)-cos(k\*L/2))./sin(theta));  polar(theta, abs(E));  figure();  %Plot 3D Pattern  pattern(h,f);  figure();  %Measure Half power beamwidth  beamwidth(h, f,0,1:1:360) |

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| **Results** |
| 1. **3D Plot: Measurement of directivity** |
| **Dipole Length=0.5λ** |
| **Dipole Length=1λ** |
| **Dipole Length=3/2λ** |
| **Dipole Length=5/2λ**  **Results** |
| 1. **2D Plot: Measurement of HPBW** |
| **Dipole Length=0.5λ**    **Dipole Length=1λ**    **Dipole Length=3/2λ**    **Dipole Length=5/2λ** |

**Observations:**

We find the Beamwidth from the 2D plots, and the Directivity from the 3D plots.

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| **Antenna Length (λ)** | **Beamwidth** | **Directivity** |
| 0.5 | 219° – 141° = 78° | 2.13 dBi |
| 1 | 204° – 156° = 48° | 3.78 dBi |
| 1.5 | 246° – 210° = 36° | 3.51 dBi |
| 2 | 252° – 224° = 28° | 4.28 dBi |

**Conclusion:**

There is a clear relationship between antenna length (λ), beamwidth and directivity; namely, that the beamwidth and directivity of the antenna increases as its length increases.