Antenna Array

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***Abstract*—This manual introduces the dipole antenna array**

Problem 1. An array of two infinitesimal horizontal dipoles positioned along the z-axis.The total field radiated by the two elements is equal to the sum of the two.

$$\begin{aligned} E_\theta &= E_1 + E_2 \\ &= j\eta \frac{kI_0 l}{4\pi}\left\{\frac{e^{-j[kr_1-\beta/2]}}{r_1}\cos\theta_1 + \frac{e^{-j[kr_2+\beta/2]}}{r_2}\cos\theta_2\right\} \end{aligned} \tag{1.1}$$

where β is phase excitation between elements. The far-zone field of a uniform two-element array of identical elements is equal to the product of the field of a single element and the array factor (AF) of that array. Using the approximations

$$\begin{aligned} &\theta_1 \approx \theta_2 \approx \theta \\ &r_1 \approx r - \frac{d}{2}\cos\theta && \text{phase variations} \\ &r_2 \approx r + \frac{d}{2}\cos\theta && \text{phase variations} \\ &r_1 \approx r_2 \approx r && \text{amplitude variations} \end{aligned}$$

Express $E_\theta = E_0$ (field of single infinitesimal dipole) $*AF$ and show that

$$AF = 2\cos\left[\frac{1}{2}(kd\cos\theta + \beta)\right] \tag{1.2}$$

Problem 2. Draw the polar plots of normalized array factor and total electric field for two-element array with $\beta = -90°$ and $d = \lambda/4$

Problem 3. Let all the N elements of the linear array have identical amplitudes but each succeeding element has a β progressive phase excitation relative to the preceding one. Show that

$$AF = \left[\frac{\sin(\frac{N}{2}\psi)}{\sin(\frac{1}{2}\psi)}\right] \tag{3.1}$$

Problem 4. Let

$$AF = \left[\frac{\sin(\frac{N}{2}\psi)}{\frac{N}{2}\psi}\right] \tag{4.1}$$

Find the value of θ for which the maximum and nulls of the array factor occurs.

Problem 5. *Broadside Array:* The maximum radiation of an array directed normal to the axis of the array. Find the condition for the uniform array to act as broadside array

*End-Fire Array:*The maximum radiation of an array directed along the axis of the array. Find the condition for the uniform array to act as end-fire array

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