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so many fake sites. this is the first one which worked! Many thanks

6.1. a.  $E_x = E_1 + E_2 + E_3 = 2E_0 \frac{e^{jkr}}{r} + E_0 \frac{e^{jkr}}{r} + E_0 \frac{e^{jkr}}{r}$

where the center element is placed at the origin. For far-field observations

$r_1 \approx r - d \cos \theta$   
 $r_2 \approx r + d \cos \theta$  } for phase variations

$r_1 \approx r_2 \approx r$  for amplitude variations

and  $E_x = E_0 \frac{e^{jkr}}{r} \left\{ 2 + e^{jk d \cos \theta} + e^{-jk d \cos \theta} \right\}$

$\approx E_0 \frac{e^{jkr}}{r} \left\{ 2 \left[ 1 + \cos(kd \cos \theta) \right] \right\}$

$= E_0 \frac{e^{jkr}}{r} \left\{ 2 \left[ 1 + \cos(kd \cos \theta) \right] \right\}$

Thus the array factor is equal to

$AF(\theta) = 2 \left[ 1 + \cos(kd \cos \theta) \right] = 4 \cos^2 \left( \frac{kd}{2} \cos \theta \right)$

which in normalized form can also be written as

$AF(\theta)_n = 1 + \cos(kd \cos \theta) = 2 \cos^2 \left( \frac{kd}{2} \cos \theta \right)$

b. The nulls of the pattern can be found using either of the above forms for the array factor. For example

One form the other form

$AF(\theta) = 1 + \cos(kd \cos \theta) = 0 \Rightarrow \cos(kd \cos \theta) = -1$

$\cos(kd \cos \theta) = -1 \Rightarrow kd \cos \theta = \cos^{-1}(-1) = \pi, 3\pi, 5\pi, \dots$

$kd \cos \theta = \cos^{-1}(-1) = \pi, n\pi, 2\pi, \dots \Rightarrow \cos \theta = \frac{\pi}{kd} (n\pi), n=1, 2, 3, \dots$

$\theta_n = \cos^{-1} \left( \frac{n\pi}{kd} \right), n=1, 2, 3, \dots$

which are of identical form. Therefore both forms yield the same results. Thus for  $d = \lambda/4$

$\theta_n = \cos^{-1} \left( \frac{n\pi}{\lambda/4} \right) = \cos^{-1}(4n) \Rightarrow \theta_n = \cos^{-1}(4n), n=1, 2, 3, \dots \Rightarrow$  No nulls exist.

c. Similarly the maxima of the pattern can be found using either of the two forms for the array factor. For example.

(Continued)

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