PROBLEM A6

PLOT THE RADIATION PATTERN OF A UNIFORM LINEAR ARRAY OF ISOTROPIC RADIATORS HAVING THE FOLLOWING PARAMETERS : NUMBER OF ISOTROPIC RADIATORS = 5, SEPARATION BETWEEN NEIGHBOURING RADIATORS = 2 mm , PHASE DIFFERENCE BETWEEN NEIGHBOURING RADIATORS = $-4\pi/5$ AND WORKING FREQUENCY = 60 GHz

SOLUTION

$$\lambda = \frac{c}{f} = \frac{3\,10^8}{60\,10^9} = 5\,10^{-3}\ m = 5\ mm \qquad d = 2\ mm \qquad \alpha = -\frac{4}{5}\pi$$

- MAXIMUM DIRECTIONS $\psi = 0, \pm 2\pi, \pm 4\pi, \pm 6\pi, \ldots$

$$\psi = 0 \qquad \psi = \frac{2\pi}{\lambda} d \cos\theta + \alpha = \frac{4}{5}\pi \cos\theta + \frac{4}{5}\pi = 0$$

$$\cos\theta - 1 = 0$$

$$\theta = 0^\circ$$

$$\psi = \pm 2\pi \qquad \psi = \frac{4}{5}\pi\left(\cos\theta - 1\right) = \pm 2\pi$$

$$\cos\theta - 1 = \pm\frac{5}{2} \quad \text{NO SOLUTION}$$

THERE IS ONLY ONE MAXIMUM DIRECTION $\theta = 0^\circ$

- NULL DIRECTION $\psi = \pm \frac{2k\pi}{N}$

$k = 1$ $\qquad \psi = \pm \frac{2\pi}{4} = \pm\frac{\pi}{2} \qquad \frac{4}{5}\pi\left(\cos\theta - 1\right) = \pm\frac{\pi}{2}$

$$\cos\theta - 1 = \pm\frac{5}{8}$$

$$\cos\theta = 1 \pm \frac{5}{8} \quad \text{NO SOLUTION}$$

$$\cos\theta = 1 - \frac{5}{8} = \frac{3}{8} \qquad \theta = \arccos\left(\frac{3}{8}\right) = \pm 68^\circ$$

$k=2$ $\quad \psi = \pm \frac{4\pi}{4} = \pm \pi \qquad \frac{4}{5}\pi\left(\cos\theta - 1\right) = \pm \pi$

$\cos\theta - 1 = \pm \frac{5}{4}$

$\cos\theta = 1 + \frac{5}{4}$ NO SOLUTION

$\cos\theta = 1 - \frac{5}{4} = -\frac{1}{4} \qquad \theta = \arccos\left(-\frac{1}{4}\right) \qquad \theta = \pm 104{,}5°$

$k=3$ $\quad \psi = \pm \frac{6\pi}{4} = \pm \frac{3}{2}\pi \qquad \frac{4}{5}\pi\left(\cos\theta - 1\right) = \pm \frac{3}{2}\pi$

$\cos\theta - 1 = \pm \frac{15}{8}$

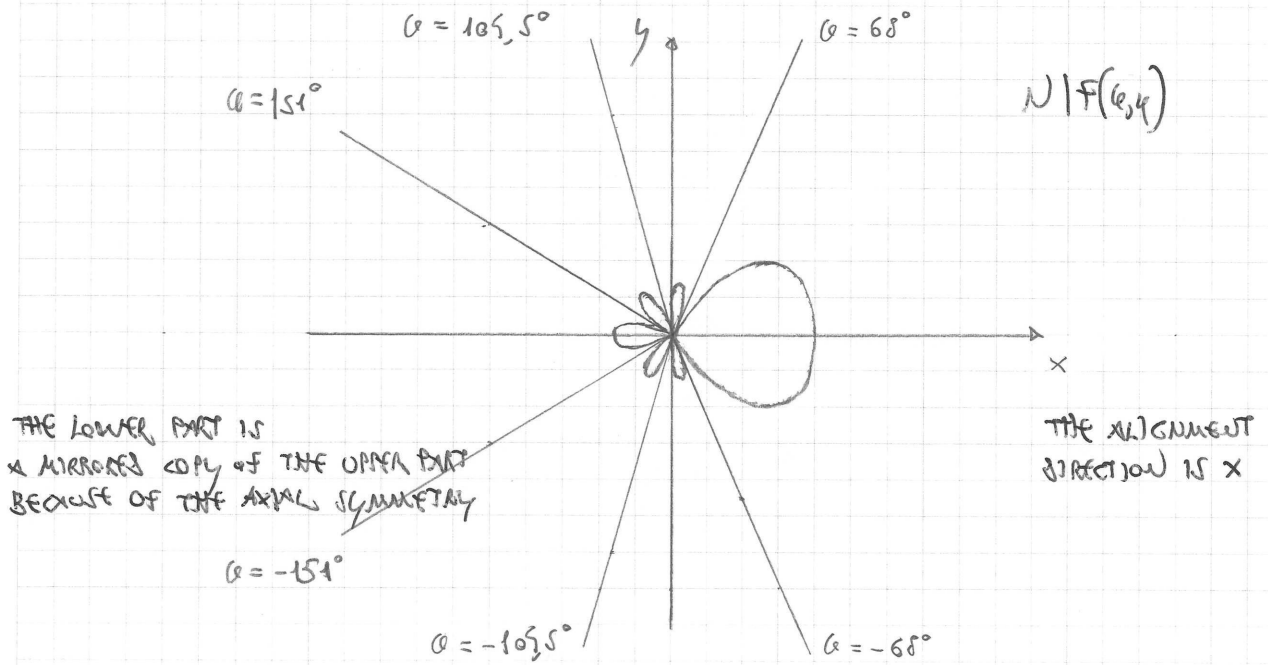
$\cos\theta = 1 + \frac{15}{8}$ NO SOLUTION

$\cos\theta = 1 - \frac{15}{8} = -\frac{7}{8} \qquad \theta = \arccos\left(-\frac{7}{8}\right) \qquad \theta = \pm 151°$

$k=5$ $\quad \psi = \pm \frac{10\pi}{4} = \pm \frac{5}{2}\pi \qquad \frac{4}{5}\pi\left(\cos\theta - 1\right) = \pm \frac{5}{2}\pi$

$\cos\theta - 1 = \pm \frac{25}{8}$ NO SOLUTION

THE NULL DIRECTIONS ARE $\theta = \pm 68°, \pm 104{,}5°, \pm 151°$



$N\,|F(\theta,\varphi)|$

THE LOWER PART IS A MIRRORED COPY OF THE UPPER PART BECAUSE OF THE AXIAL SYMMETRY

THE ALIGNMENT DIRECTION IS x

THERE IS ONE MAIN LOBE, BUT THERE ARE FIVE SECONDARY LOBES