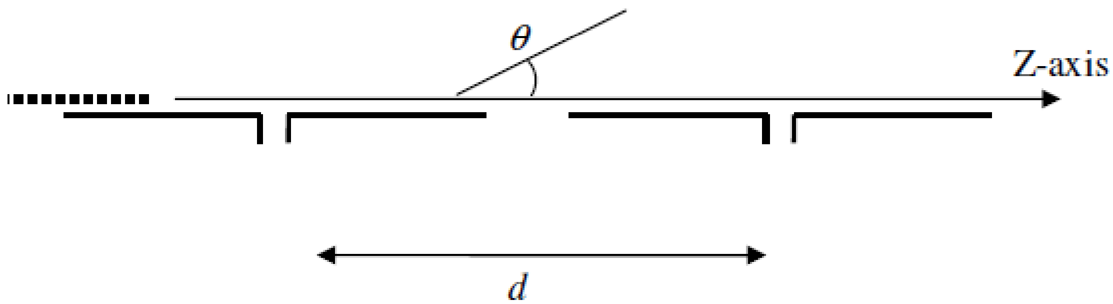
Question:



In this assignment you are required to design an array of N dipoles as shown in Figure 1, so that the beam has the following characteristics:
i. Half power beamwidth = 20° (± 1°)
ii. Beam pointing angle (or beam position) = 60° (± 1°)
iii. Only one major lobe in the $_{o\,o}$0 <q <180 region. Meaning no grating lobes.

What you have to do is to determine the number of elements, spacing and progressive phase shift in order to achieve the design goals. Design is an iterative process. You have to start somewhere. Say for example you start with 2 dipoles with a spacing of half wavelength. Then, you determine the phase shift by using the formula. Next with the help of MATLAB or any other tools (there are many antenna plotting tools available in the internet), calculate the 3dB beamwidth and beam max point. If beamwidth is not as desired, then you need to change one of your parameter. Then repeat again. MALTAB or other tools will help in plotting the array factor.

Answer:

Given above shows an array of half-wave dipoles spaced *d* apart. Now designing an array of N dipoles so that the beamwidth to have the following characteristics:

i. Half power beamwidth = 20° (± 1°)
ii. Beam pointing angle (or beam position) = 60° (± 1°)
iii. Only one major lobe in the 0° <q <180° region. No grating lobes.

To determined the number of elements, spacing and progressive phase shift in order to achieve the design goals.

We let: $\boldsymbol{d = \frac{\lambda}{2}}$ and $\lambda = 2$

Now from $\psi = \beta d cos(\theta) + \alpha = \pi\ 0$

$\alpha = -\beta d cos(\theta)$ Where $d = 1$ from above, $\beta = \frac{2\pi}{\lambda}$ = and θ = 60°

$\alpha = -\pi \times cos(60^{\circ})$

$\alpha =$ **-1.5708**

Now to find the number of elements, we use $HPBW = 50.78^{\circ}\frac{\lambda}{Nd}$
Given $HPBW = 20^{\circ}$

Therefore, $50.78^{\circ}\frac{\lambda}{Nd} = 20^{\circ}$

$N = \frac{20^{\circ}}{50.78^{\circ}} \times \frac{\lambda}{d}$ Where λ = 2 & d = 1

$N = 5.076 \approx$ **5**

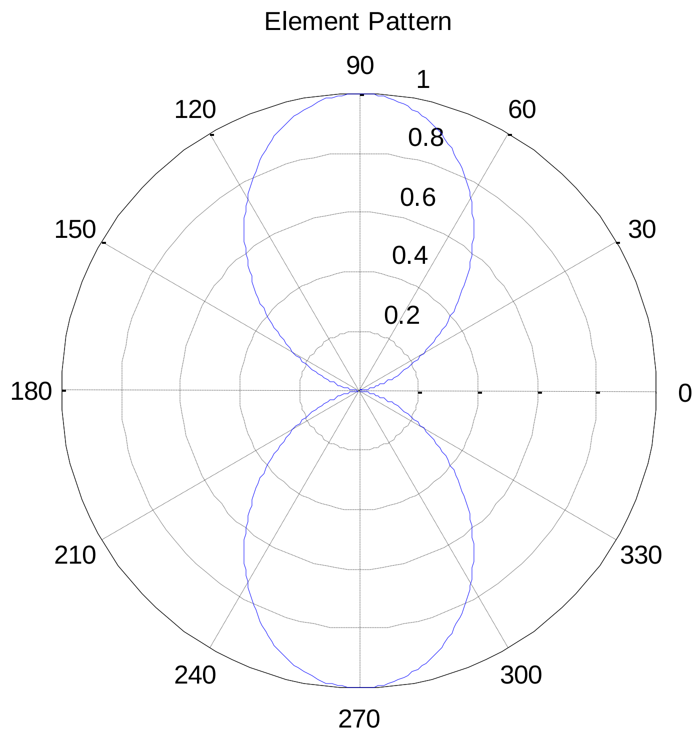
Now with the calculated number of elements($N = 5$), spacing ($d = 1$) and progressive phase shift($\alpha = -1.5708$), we compute this using MATLAB to view the designed total pattern.

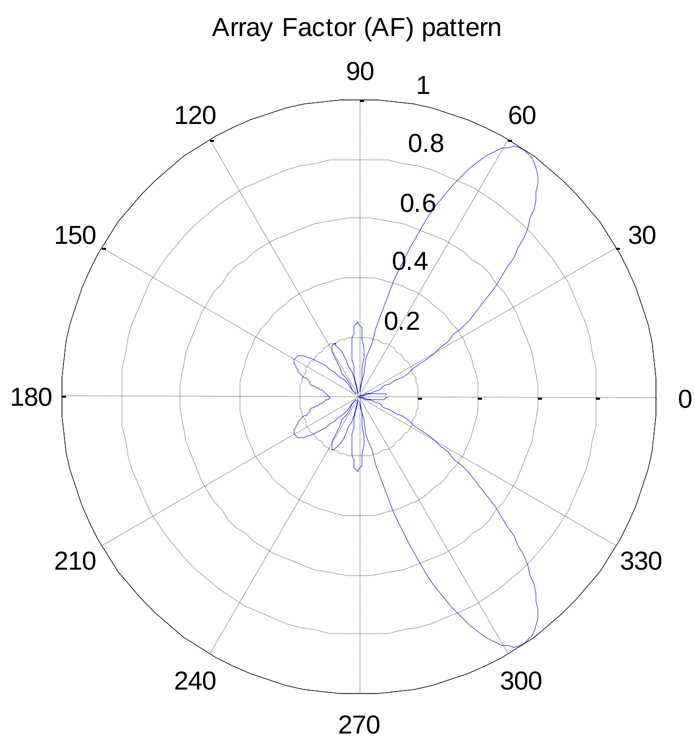
MATLAB CODE:

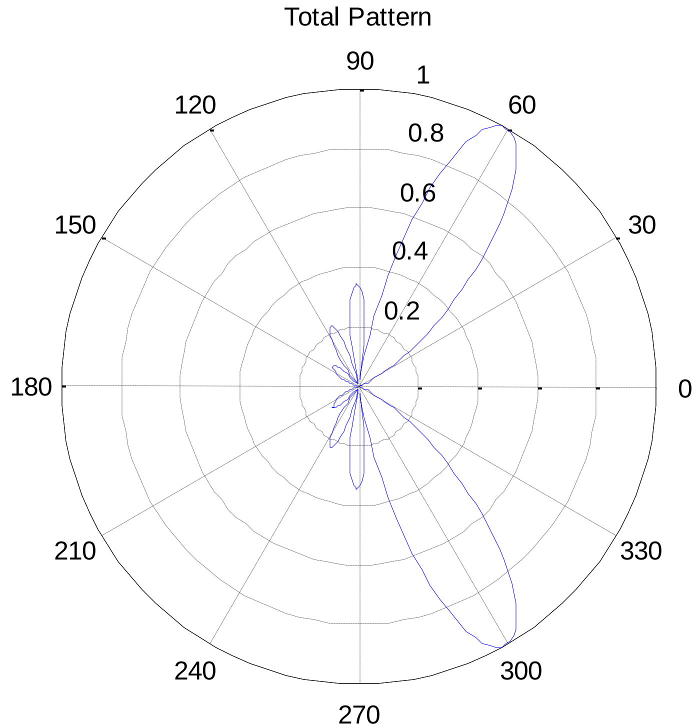
```
lambda=2;
HPBW=20;
N=floor(50.76*m/HPBW)
theta=linspace(0,2*pi,360);
alpha=-2*pi*cos(55*pi/180)/lambda;
for k=1:length(theta)
    Psi=2*(pi/m)*cos(theta(k))+alpha;
    if(sai==0)
        AF(k)=N;
    else
        AF(k)=sin(Psi*N/2)/sin(Psi/2);
    end
end
AF=abs(AF./max(AF));
dipole=(sin(theta)).^2;
Total_Pattern=dipole.*AF;
Total_Pattern=Total_Pattern./max(Total_Pattern);

figure(1),polar(theta,AF)
title('Array Factor (AF) pattern')
figure(2),polar(theta,dipole)
title('Element Pattern')
figure(3),polar(theta,Total_Pattern)
title('Total Pattern')

%to check the peak is at 60 degrees
index=find(Total_Pattern>0.99)
```


Element Pattern
90
1
120
60
0.8
0.6
150
30
0.4
0.2
180
0
210
330
240
300
270


Array Factor (AF) pattern
90
1
120
60
0.8
0.6
150
30
0.4
0.2
180
0
210
330
240
300
270



Total Pattern
90
1
60
0.8
120
0.6
150
30
0.4
0.2
180
0
210
330
240
300
270