Homework 6: ECE 4370, Fall 2012

Due 11/8/2012

1) How many turns of a helical antenna are required to achieve a peak gain of 13 dBi, given standard construction parameters of 1-wavelength circumference and a 13-degree pitch angle? What is the half-power beamwidth for such an antenna?

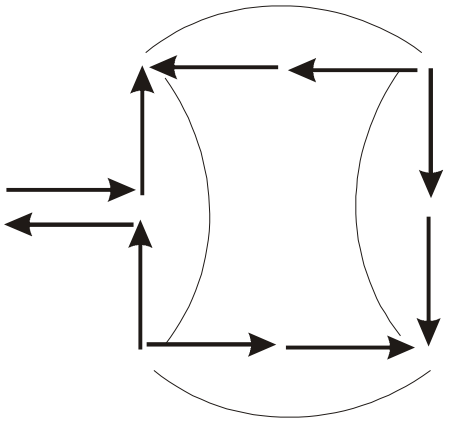
   Peak Directivity = $15\, N\, C^2\, S/\lambda^3 = 15\, N \tan\alpha = 13$ dBi

   This occurs for approximately N = 6.

   The HPBW would be $52\, \lambda^{3/2}/C/(NS)^{1/2} = 52/(N \tan\alpha)^{1/2} = 44$ degrees

2) Radiation of a 2-wavelength, center-fed, square loop antenna lying in the xy-plane:

   a) A sketch of the 2λ square loop antenna currents would look like this:



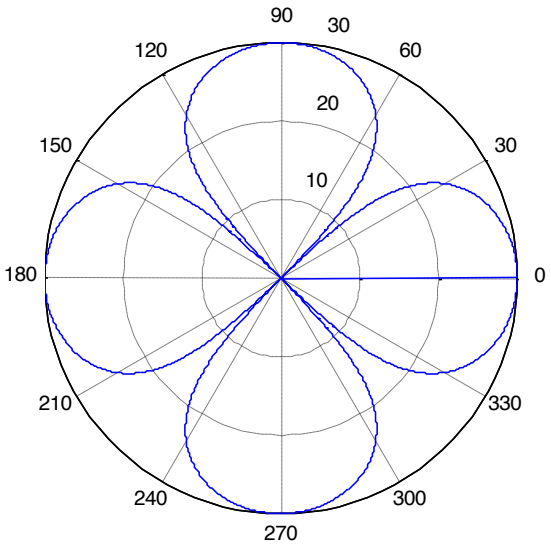
   b) The radiation pattern of this loop is essentially that of 4 half-wave dipoles, laid on their sides in the xy-plane. With the center as the reference, here is a convenient table of the patterns and array factors for each element:

	Pattern	Array Factor
Top	$\cos(\pi/2\cos\phi)/\sin(\phi)$	$\exp(j\pi/2\sin\phi)$
Bottom	$-\cos(\pi/2\cos\phi)/\sin(\phi)$	$\exp(-j\pi/2\sin\phi)$
Left	$-\cos(\pi/2\sin\phi)/\cos(\phi)$	$\exp(j\pi/2\cos\phi)$
Right	$\cos(\pi/2\sin\phi)/\cos(\phi)$	$\exp(-j\pi/2\cos\phi)$

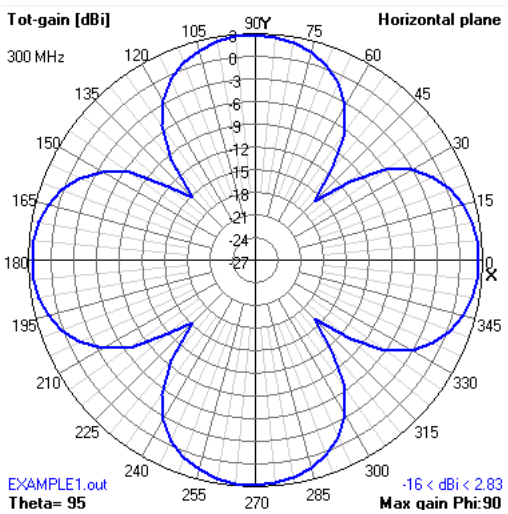
   To see the azimuth pattern, we plot in Matlab (with 30 dB offset to see nulls)

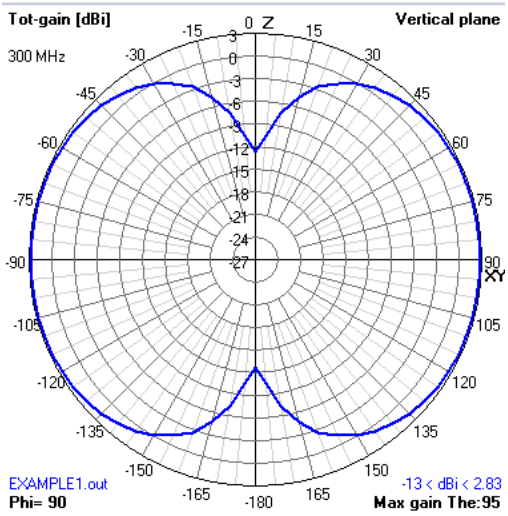
Azimuth Cut (Matlab™ code)

```
phi=0:.001:2*pi;
E1= cos(pi/2*cos(phi)).*sin(pi/2*sin(phi))./sin(phi);
E2= cos(pi/2*sin(phi)).*sin(pi/2*cos(phi))./cos(phi);
polar(phi,max(0,20*log10(abs(E1-E2))+30));
```



c) Here are the NEC inputs and outputs to double check:





Symbols | **Geometry** | Source/Load | Freq./Ground | Others

Geometry (Scaling=Meters) ☐ Use

Nr	Type	Tag	Segs	X1	Y1	Z1	X2	Y2	Z2	Radius
1	Wire	1	9	.25	-.25	0	.25	.25	0	.0001
2	Wire	2	9	.25	.25	0	-.25	.25	0	.0001
3	Wire	3	9	-.25	.25	0	-.25	-.25	0	.0001
4	Wire	4	9	-.25	-.25	0	.25	-.25	0	.0001