

Plot the directivity of the antenna of 13.28a versus ϕ for $\theta = \pi/2$ as two (unitless and in dBi) polar plots using MATLAB. What is the maximum directivity D_{\max} (unitless and in dBi)? At what angle or angles does D_{\max} occur? What is the half-power beamwidth HPBW?

13.28 For each of the following radiation intensities, calculate the directive gain and directivity.

(a) $U(\theta, \phi) = 10 \sin \theta \sin^2 \phi$, $0 < \theta < \pi, 0 < \phi < 2\pi$

From 13.28 a, $D(\theta, \phi) = 2.54648 \sin \theta \sin^2 \phi$ $0 < \theta < \pi$
 $0 < \phi < 2\pi$

$$\underline{\underline{D_{\max} = 2.5465 = 4.0594 \text{ dBi}}}$$

$$\underline{\underline{@ \theta = \pi/2 \text{ \& } \phi = \pi/2 \text{ \& } \text{or } 3\pi/2}}$$

The HP points occur, on the $\theta = \pi/2$ plane, when

$$D(\theta = \pi/2, \phi) = 2.546485 \sin \pi/2 \sin^2 \phi_h = \frac{D_{\max}}{2} = \frac{2.546485}{2}$$

$$\hookrightarrow \sin^2 \phi_h = 1/2$$

$$\hookrightarrow \phi_h = \sin^{-1}(1/\sqrt{2}) = 45^\circ \text{ \& } 135^\circ$$

or

$$= 225^\circ + 315^\circ$$

$$\underline{\underline{\text{HPBW} = 135^\circ - 45^\circ = 90^\circ}}$$

around $\phi_{\max} = \pi/2 + 3\pi/2$ points

See following pages for radiation patterns.

```

% EE382 problem 13.28a (p13_28a_extended.m)
% Plot the directivity (wrt phi) for theta = 90 deg
% in both unitless and dBi forms for 13.28a
% D = 2.54648 sin(theta) sin^2(phi) for 0 < phi < 360 deg
%
clear; clc; close all; % make sure Matlab doesn't have old info
theta = pi/2;
n = 0 : 1 : 359;
phi = n*pi/180; % convert angles to radians
D = 2.54648*sin(theta)*(sin(phi)).^2;
% ***** Plot D in dBi format *****
radpat(phi*180/pi,D,'r-');
% ***** Plot d in dimensionless format *****
figure;
radpat(phi*180/pi,D,'r-'); % trick it into doing a
% unitless plot by saying the input values are already
% in dB (that way it won't take the logarithm of the data).
%
set(findobj('type','line'),'linewidth',1.5)
set(findobj('type','axes'),'linewidth',2)

```

MATLAB command window entries (for radpat.m)

(these are the lines for the dBi plot)

Are input values in dB (Y/N)[Y]? N

Input values proportional to power (Y/N) [Y]? Y

% radpat.m will take $10\log_{10}(D)$

Normalize to the Maximum Gain Value (Y/N)[Y]? N

Maximum dB value for outer circle of plot [0]? 5

% know $D_{\max} = 4.06$ dBi

Minimum dB value at plot center [-40]? -30

Are the angles theta values? (Y/N)[Y]? N

0 deg at North/Top or East/Right (N/E)[N]? E

Labels on Vertical or Horizontal axis (V/H)[V]? V

Pattern line width [1.25]: 1.5

Line type of grid(-, --, -., :)[:]: :

(these are the lines for the unitless plot)

Are input values in dB (Y/N)[Y]? Y

% trick radpat.m into plotting unitless D

Normalize to the Maximum Gain Value (Y/N)[Y]? N

Maximum dB value for outer circle of plot [0]? 3

% know $D_{\max} = 2.5465$

Minimum dB value at plot center [-40]? 0

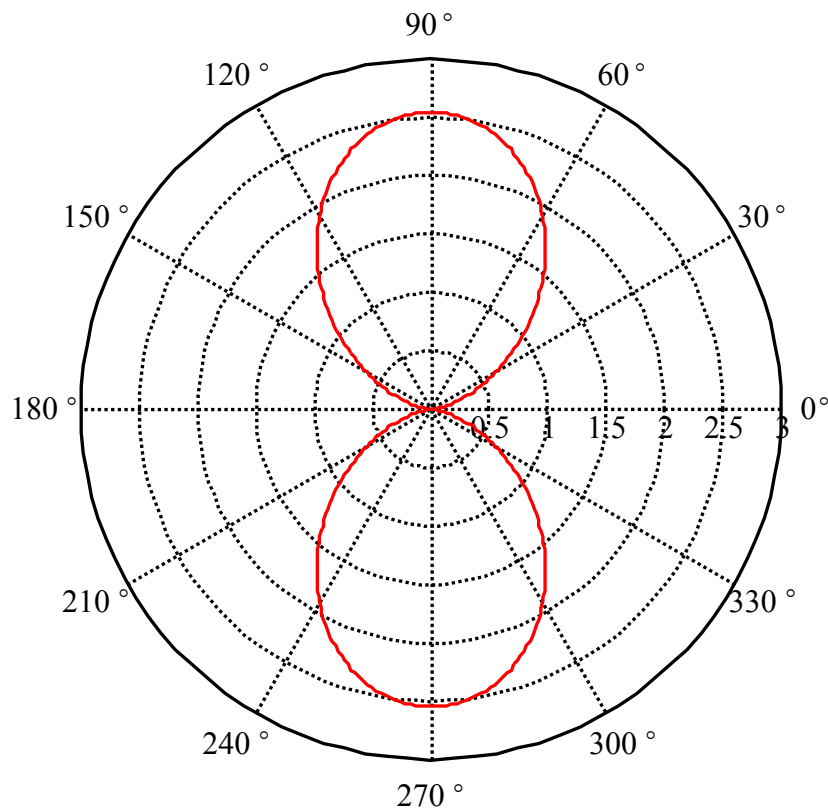
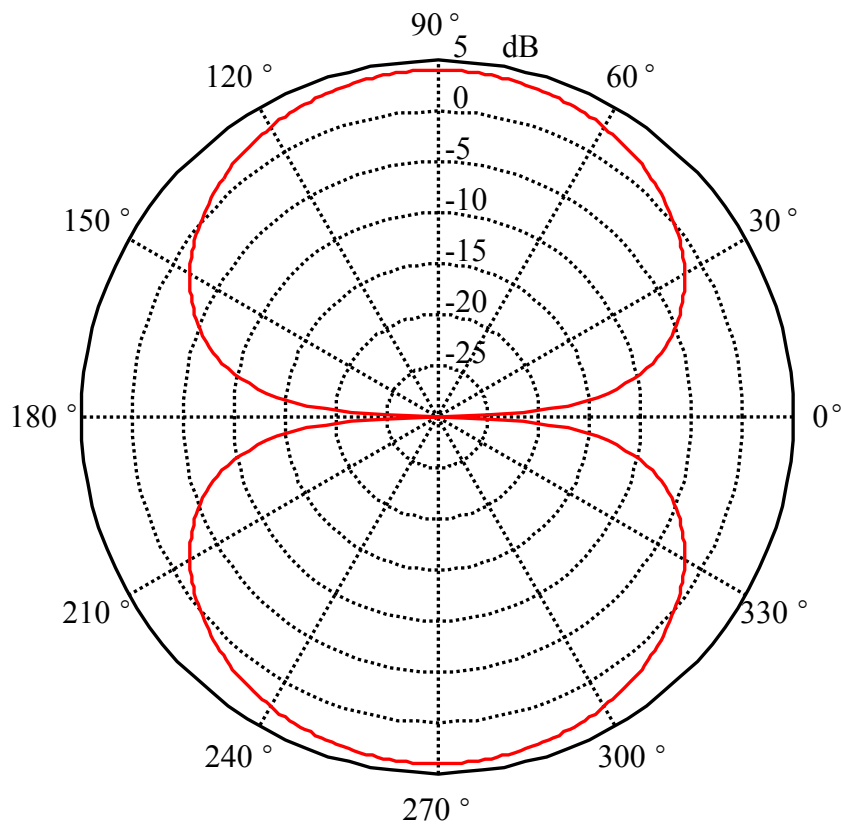
Are the angles theta values? (Y/N)[Y]? N

0 deg at North/Top or East/Right (N/E)[N]? E

Labels on Vertical or Horizontal axis (V/H)[V]? H

Pattern line width [1.25]: 1.5

Line type of grid(-, --, -., :)[:]: :

Figure 1 Unitless radiation pattern of D Figure 2 Radiation pattern of D (dBi), i.e., $10 \log_{10}(D)$.