```
% DipoleArray.m (ver 2.0)
% Author:  Greg Durgin                  Date: 27 September 2011
% Modified by Andrew McRae, October 1, 2015
% Updated by Caitlyn Caggia, October 31, 2018
%
% Compute the pattern and electrical parameter for a stack of
% N vertical half-wave dipoles.
clear all; close all;   % initialize

for i=1:5
    % User-defined inputs
    I = 1;                  % current amplitude (Amps)
    N = i;                  % number of stacked half-wave, in-phase
 dipoles
    M = 200000;             % number of elevation points to plot
    dB_min = -30;           % minimum gain to plot in polar
 coordinates

    % Initialized variables
    M = 2*ceil(M/2);        % ensure M is even
    mu_0 = 4*pi*1e-7;       % permeability of free space (H/m)
    ep_0 = 8.85e-12;        % permittivity of free space (F/m)
    eta = (mu_0/ep_0)^.5;   % impedance of free space (Ohms)
    theta = (0:M)/M * pi;   % generate range of elevation angles (rad)

    % Generate power pattern (actually S*r^2)
    S = tan(theta).^2 .* I^2 .* sin(N*pi/2 .* cos(theta)).^2;
    S(1) = 0; S(end)=0;     % zero out nulls due to singularity
    P_tot = sum(S.*sin(theta))*pi/(M+1)*2*pi;   % radiated power (W/
m^2)
    D = 4*pi*S/P_tot;                           % compute directivity

    % Plotting functions
    figure
    theta_p = (0:(2*M+1))/2/M * 2*pi;       % index with Matlab polar
 coords
    D_plot = [ fliplr(D(1:M/2)) D fliplr(D(M/2+1:end)) ];
    DdB = max(10*log10(abs(D_plot)),dB_min)-dB_min; % compute log
 directivity (dB)
    polar(theta_p,DdB);                     % plot the directivity
 (dB)
    if N == 1
        title('Directivity of a \lambda/2 wire');
    else
        title(sprintf('Directivity of %i \\lambda/2 wire', N));
    end
    axis off;

    % Radiation parameter computation
    Gpeak = max(D);                 % peak gain computation
    Rrad = 2*P_tot/(N*I)^2;         % radiation resistance calculation
    hpbw = sum(D >= Gpeak/2)/M*180;      % calculate half-power BW
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    %Calculate null nearest to main lobe
    mainLobeNull = acos(2/N);

    %Find side-lobe level; max that is outside the main lobe nulls
    SLL = max(D(theta < mainLobeNull))/Gpeak;

    % Display results
    fprintf('\n\n Wire with %i element(s)', N);
    fprintf('\n Element input current %2.1f A', N*I );
    fprintf('\n ------------------------------------------------');
    fprintf('\n Total radiated power:   %3.1f W/m^2 (%2.1f dBW)', ...
        P_tot, 10*log10(P_tot) );
    fprintf('\n Peak gain:              %3.1f (%2.1f dBi)', ...
        Gpeak, 10*log10(Gpeak) );
    fprintf('\n Half-power beamwidth:   %2.1f deg', hpbw);
    fprintf('\n Side-lobe level:        %2.1f dB', -10*log10(SLL) );
    fprintf('\n Radiation resistance:   %3.1f Ohms', Rrad );
    fprintf('\n Gain-beamwidth product: %3.2f deg', hpbw*Gpeak);
    fprintf('\n\n');
end
```

```
 Wire with 1 element(s)
 Element input current 1.0 A
 ------------------------------------------------
 Total radiated power:   17.7 W/m^2 (12.5 dBW)
 Peak gain:              1.8 (2.4 dBi)
 Half-power beamwidth:   70.8 deg
 Side-lobe level:         dB
 Radiation resistance:   35.4 Ohms
 Gain-beamwidth product: 124.01 deg


 Wire with 2 element(s)
 Element input current 2.0 A
 ------------------------------------------------
 Total radiated power:   49.7 W/m^2 (17.0 dBW)
 Peak gain:              2.5 (4.0 dBi)
 Half-power beamwidth:   45.9 deg
 Side-lobe level:         dB
 Radiation resistance:   24.9 Ohms
 Gain-beamwidth product: 114.56 deg


 Wire with 3 element(s)
 Element input current 3.0 A
 ------------------------------------------------
 Total radiated power:   80.3 W/m^2 (19.0 dBW)
 Peak gain:              3.5 (5.4 dBi)
 Half-power beamwidth:   32.4 deg
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Side-lobe level:        20.0 dB
Radiation resistance:   17.9 Ohms
Gain-beamwidth product: 112.45 deg


Wire with 4 element(s)
Element input current 4.0 A
-----------------------------------------------
Total radiated power:   111.5 W/m^2 (20.5 dBW)
Peak gain:              4.4 (6.5 dBi)
Half-power beamwidth:   24.8 deg
Side-lobe level:        16.2 dB
Radiation resistance:   13.9 Ohms
Gain-beamwidth product: 110.12 deg


Wire with 5 element(s)
Element input current 5.0 A
-----------------------------------------------
Total radiated power:   142.4 W/m^2 (21.5 dBW)
Peak gain:              5.4 (7.4 dBi)
Half-power beamwidth:   20.0 deg
Side-lobe level:        14.9 dB
Radiation resistance:   11.4 Ohms
Gain-beamwidth product: 108.76 deg
```
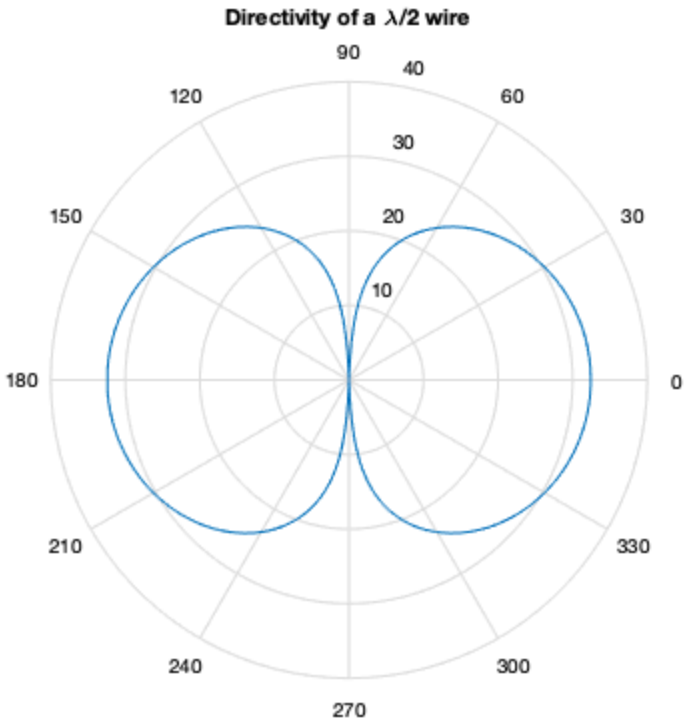
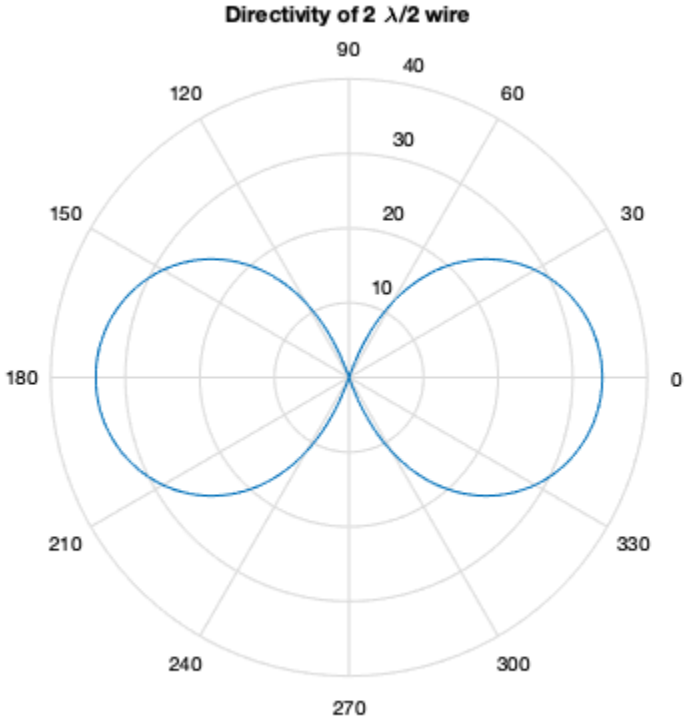
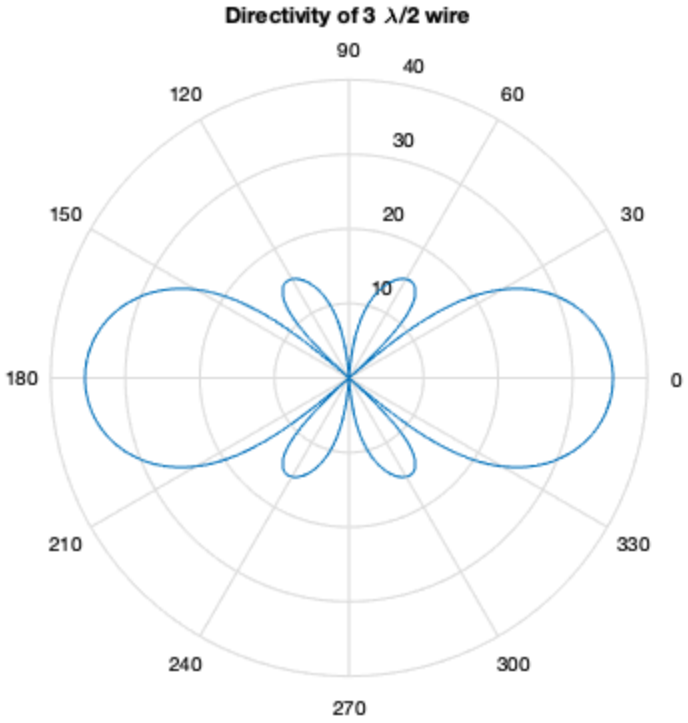
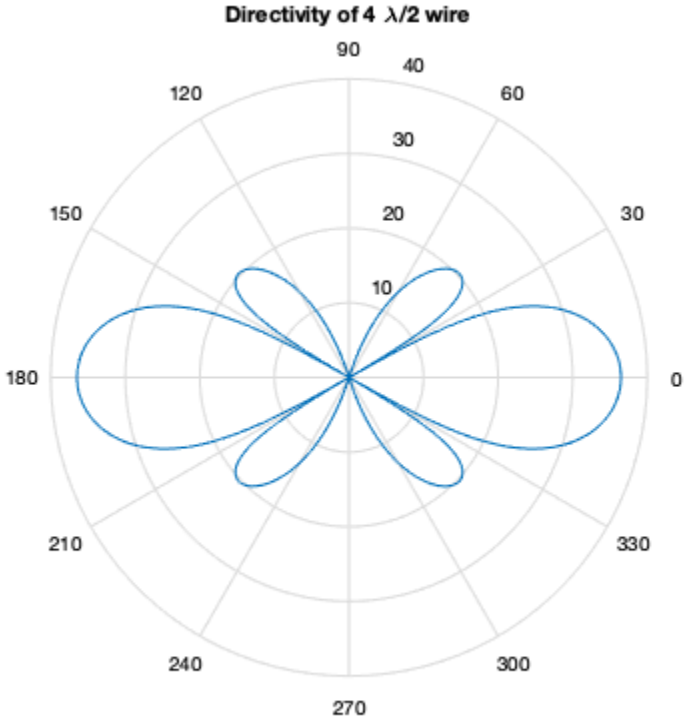
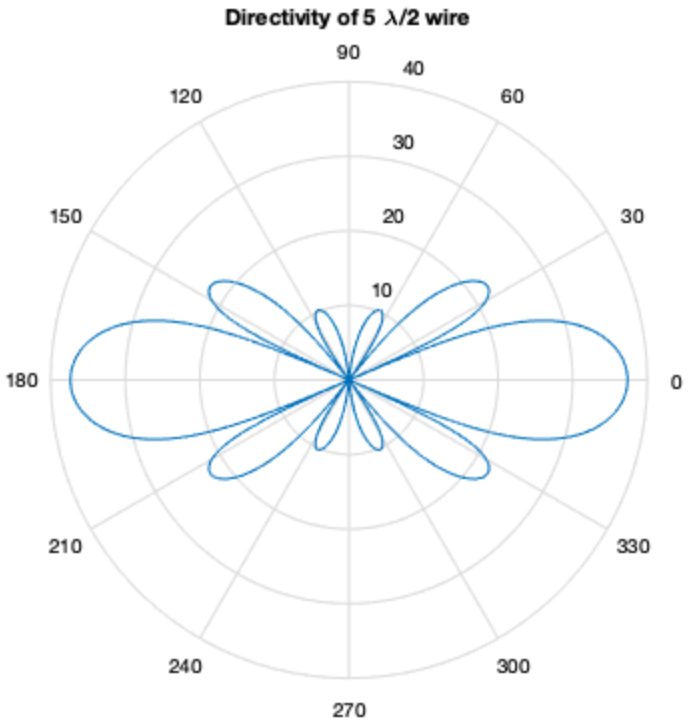


Directivity of a λ/2 wire
90
40
60
120
30
150
20
30
10
180
0
210
330
240
300
270


Directivity of 2 λ/2 wire
90
40
60
120
30
150
20
30
10
180
0
210
330
240
300
270


Directivity of 3 λ/2 wire
90
40
60
120
30
150
20
30
10
180
0
210
330
240
300
270


Directivity of 4 λ/2 wire
90
40
60
120
30
150
20
30
10
180
0
210
330
240
300
270



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