EE307 Homework 7

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Problem 1：You need to design a yagi antenna with a frequency of 260 MHz. The maximum estimated directivity is 12.93 dBi. Using the table below, calculate the dimensions of all the elements of your antenna and draw it by specifying all these dimensions.

Solution：

1) Calculate the following

- **Firstly, according to the table, we can see that in order to design the yagi antenna to meet the requirements of the question, there must be four directors. According to the data provided in the table, we can calculate the length of each director, the distance between the directors ,the distance between the reflector and the active oscillator through MATLAB, and the code is as follows:**

```
f = 260e6;
lanmuda = 3e8/f;
R = 0.482*lanmuda    %反射器的长度(单位都是米)
A = 0.47*lanmuda      %有源振子的长度
D1 = 0.428*lanmuda     %引向器1的长度
D2 = 0.420*lanmuda     %引向器2的长度
D3 = 0.420*lanmuda     %引向器3的长度
D4 = 0.428*lanmuda     %引向器4的长度
SD = 0.25*lanmuda       %引向器之间的距离
SR = 0.2*lanmuda        %反射器与有源振子之间的间距
```

- **Then, The calculation results of the above parameters are shown as follows:**

  Result:

名称	值
A	0.5423
D1	0.4938
D2	0.4846
D3	0.4846
D4	0.4938
f	260000000
lanmuda	1.1538
R	0.5562
SD	0.2885
SR	0.2308

- **Next, according to the parameters calculated above, we use MATLAB's own app "AntennaDesigner" to draw the relative parameters of the antenna, as shown below:**

```
% Create a yagiUda antenna
  % Generated by MATLAB(R) 9.10 and Antenna Toolbox 5.0.
  % Generated on: 01-Apr-2022 23:01:52

  %% Antenna Properties

  antennaObject = design(yagiUda, 260*1e6);
  antennaObject.NumDirectors = 4;
  antennaObject.DirectorLength = [0.4938,0.4846,0.4846,0.4938];
  antennaObject.DirectorSpacing = 0.2885;
  antennaObject.ReflectorLength = 0.5562;
  antennaObject.ReflectorSpacing = 0.2308;
  % Show
  figure;
  show(antennaObject)

  %% Antenna Analysis
  % Define plot frequency
  plotFrequency = 260*1e6;
  % Define frequency range
  freqRange = (234:2.6:286)*1e6;
  % pattern
  figure;
  pattern(antennaObject, plotFrequency)

```

- **Finally, we can draw the image of the antenna and the parameters related to the antenna:**

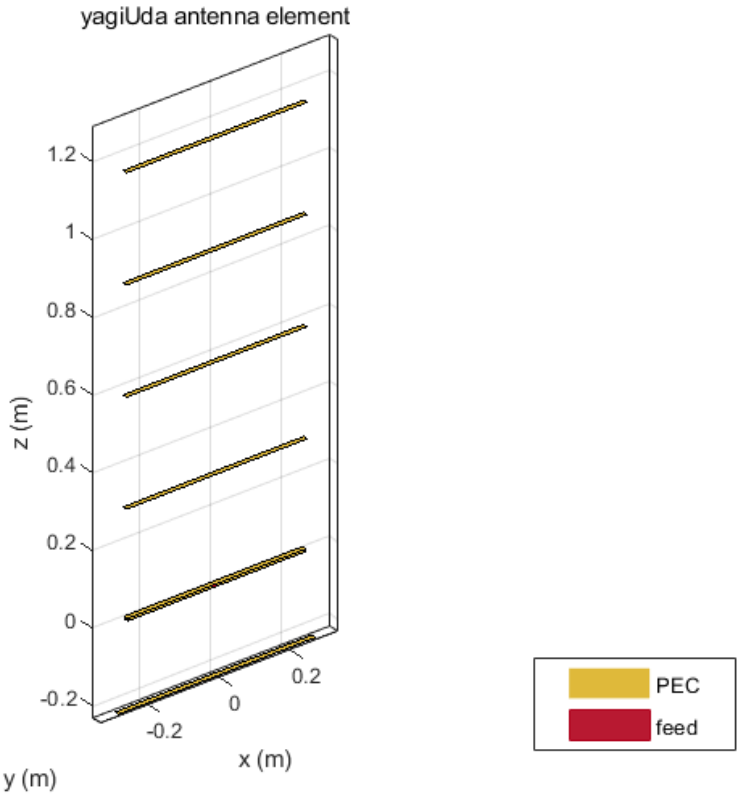

Figure1. The overall model of yagi antenna

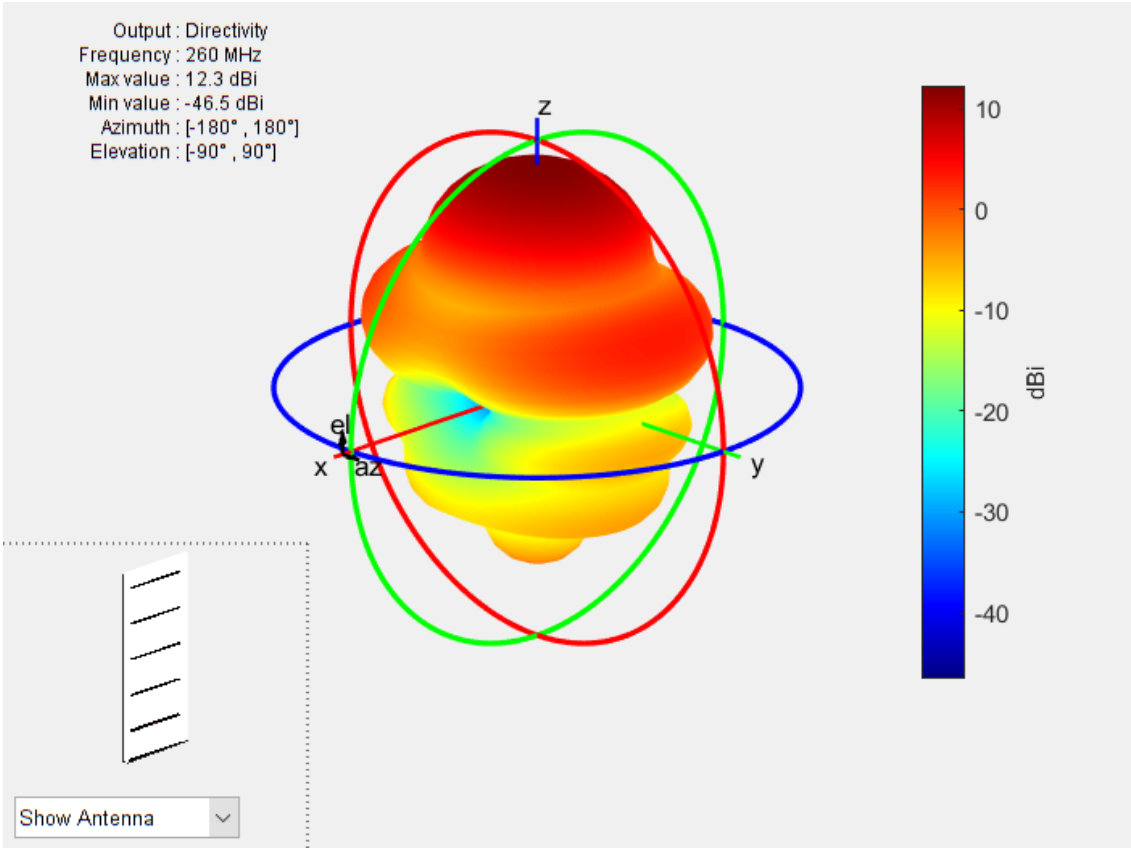

Figure2. The radiation pattern of yagi antenna

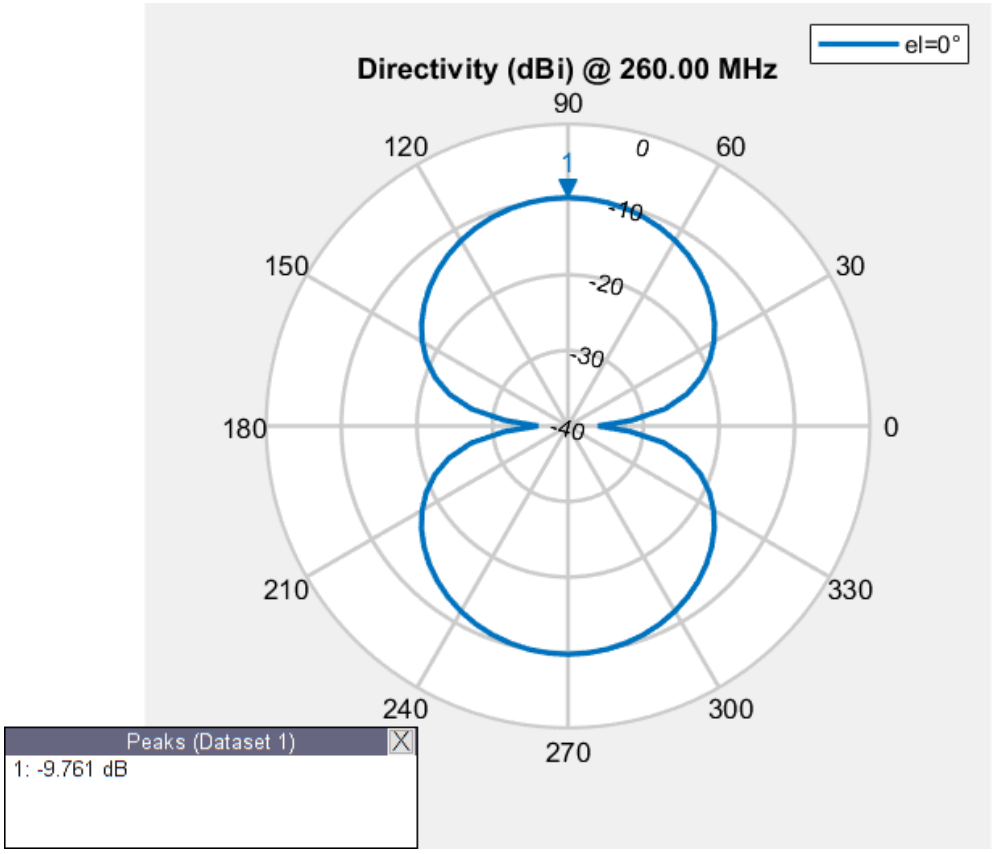

Figure3. The directivity 2D plot of yagi antenna(in elevation plane)

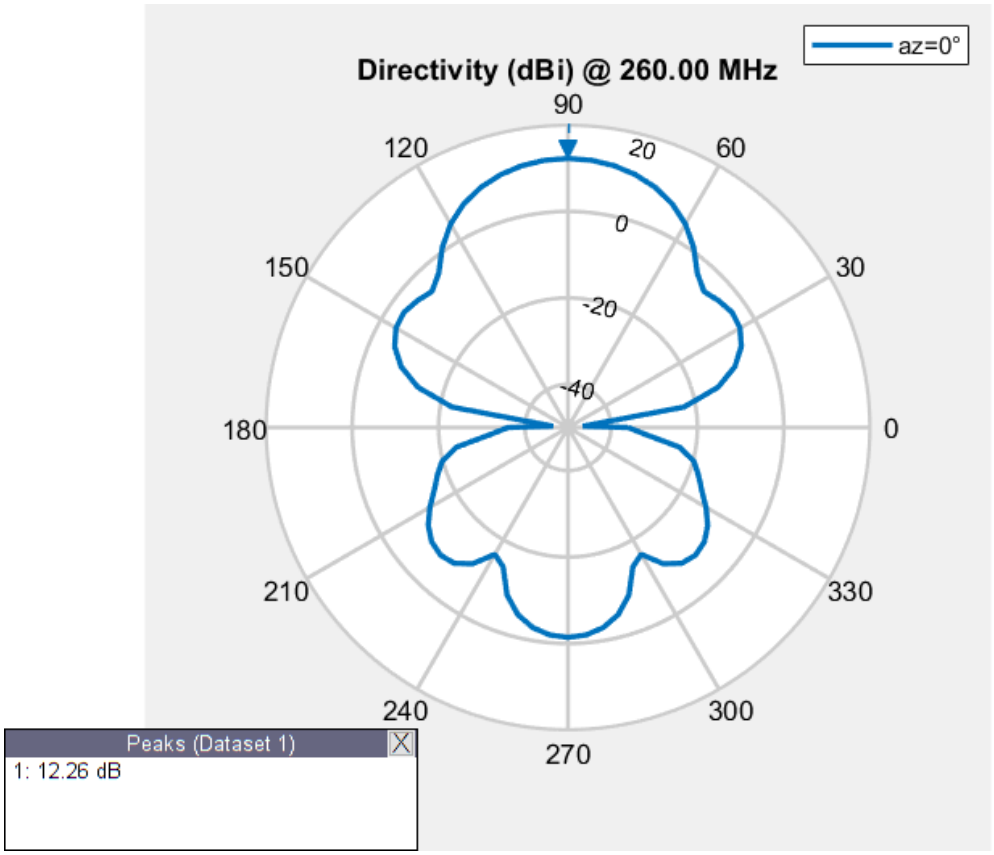

Figure4. The directivity 2D plot of yagi antenna(in azimuth plane)

- **Through the above analysis and calculation, it shows that the measured value of yagi antenna directivity is 12.3dBi, which is in good agreement with the value in the problem table. So, our results fit with the results on the course ppt very well.**

Problem 2：Design a 10-turn helix to operate in the axial mode.

Determine

a) The circumference in wavelengths, the pitch angle in degrees, and separation between turns (in wavelengths)

b) HPBW of the main lobe in degrees

c) Directivity in dB

Solution：

a)

- **Firstly, by using the formula on page 78 of the slides, we can assume that the circumference in wavelengths of this helix is 1, and the pitch angle is 14 in degrees. Therefore, based on these two assumptions, we can calculate the separation between turns with MATLAB, that is:**

```
%第一问:确定参数
N = 10;  %10 turn
lanmuda0 = 1; %默认的波长量,因为后面的量都是以波长为基准的，因此该量置为1即可
C_lanmuda = 1; % the circumference in wavelengths is 1
alpha = 14;   % alpha为14度
S_lanmuda = C_lanmuda*tand(alpha); %separation between turns (in wavelengths)
S_lanmuda
```

- **Therefore, through calculation, we can get the following results:**

```
S_lanmuda =

    0.2493
```

So, by our calculation, the circumference in wavelengths is 1, The pitch angle in degrees is 14, and the separation between turns (in wavelengths) is 0.2493.

b)

- **Firstly, by using the formula on page 78 of the slides, we can also get the HPBW of the main lobe in degrees through MATLAB, that is:**

```
%第二问:确定HPBW
HPBW = (52*lanmuda0^(1.5))/(C_lanmuda*sqrt(N*S_lanmuda));
HPBW
```

- **Therefore, through calculation, we can get the following results:**

```
HPBW =

   32.9320
```

Finally, by our calculation, the HPBW of the main lobe in degrees is 32.9320.

c)

- **Firstly, by using the formula on page 78 of the slides, we can also get the Directivity in dB through MATLAB, that is:**

```
%第三问:计算方向性
D0 = (15*N*C_lanmuda^(2)*S_lanmuda)/lanmuda0^(3);
D0
%将D0单位转化为dBi
D0_dBi = 10*log10(D0);
D0_dBi
```

- **Therefore, through calculation, we can get the following results:**

```
D0 =

   37.3992


D0_dBi =

   15.7286
```

Finally, by our calculation, the the Directivity in dB is 15.7286(dB or dBi).