Scilab Manual for Antenna Design Lab by Dr Dharmavaram Asha Devi Electronics Engineering Sreenidhi Institute Of Science And Technology[1]

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Experiment: 1

Design array to achieve optimum pattern

Scilab code Solution 1.1 Ex1

```
1  //Design array to achieve optimum pattern
2  //Windows 10
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  MainBeamwidth=45;//in degree
10 thetaN=MainBeamwidth/2;//in degree
11 thetaN=thetaN*%pi/180;//in radian
12 m=5;//no. of elements
13 //d=lambda/2 in meter
14 x=cos(%pi/(2*(m-1)));
15 xo=x/cos((%pi/2)*sin(thetaN));//unitless
16 disp("E5=ao*z+a1*(2*z^2-1)+a2*(8*z^4-8*z^2+1)");
17 disp("We Know that : z=x/xo, E5=T4*xo");
18 disp("ao=a1*(2*(x/xo)^2-1)+a2*[8*(x/xo)^4-8*(x/xo)
   ^2+1]=8*x^4-8*x^2+1");
```

```
19 disp("By comparing the term we have : ");
20 disp("a2=xo^4  a1=4*a2-4*xo^2  ao=1+a1-a2 ")
21 a2=xo^4;
22 a1=4*a2-4*xo^2;
23 ao=1+a1-a2;
24 disp("And therefore the 5 elements array is given by
       : ");
25 disp(string(a2)+"  "+string(a1)+"  "+string(2*ao)+"
       "+string(a1)+"  "+string(a2));
```

Experiment: 2

Design array of 5 elements to achieve optimum pattern

Scilab code Solution 2.2 Ex2

```
1 //Design array of 5 elements to achieve optimum
     pattern
2 //Windows 10
3 //Scilab 6.0.0
4
5 clc;
6 clear;
7 close;
8
9 //Side lobe level below main lobe
10 disp("Side lobe level below main lobe : ")
11 SideLobe=20;//in dB
12 r=10^(SideLobe/20);//
13 disp(r,"r=") ;
14 //let No. of elements =5, n=5
15 disp("No. of elements are 5, n=5 :");
16 disp("Tchebyscheff polynomials of degree (n-1) is");
17 disp("5-1=4");
18 disp("T4(xo)=r");
```

```
19 disp("8*xo^4-8*xo^2+1=10");
20 disp("By using alternate formula, we get");
21 m=4;
22 r=10;
23 xo=(1/2)*[(r+sqrt(r^2-1))^(1/m)+(r-sqrt(r^2-1))^(1/m
   )]
24 disp(xo,"xo=");
25 disp("E5=T4(xo)")
26 disp("E5=ao*z+a1*(2*z^2-1)+a2*(8*z^4-8*z^2+1)");
27 disp("We Know that : z=x/xo, E5=T4*xo");
28 disp("ao=a1*(2*(x/xo)^2-1)+a2*[8*(x/xo)^4-8*(x/xo)
   ^2+1]=8*x^4-8*x^2+1");
29 disp("By comparing the term we have : ");
30 disp("a2=xo^4  a1=4*a2-4*xo^2  ao=1+a1-a2 ")
31 a2=xo^4;
32 a1=4*a2-4*xo^2;
33 ao=1+a1-a2;
34 disp("And therefore the 5 elements array is given by
    : ");
35 disp(string(a2)+"  "+string(a1)+"  "+string(2*ao)+"
    "+string(a1)+"  "+string(a2));
```

Experiment: 3

Design of Simple End Fire Array

Scilab code Solution 3.3 Ex3

```
1  //Design of simple End Fire Array
2  //Windows 10
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  format('v',6);
10 D=20;//dB(Directivity)
11 //d=lambda/4;(spacing)
12 dBYlambda=1/4;//(spacing/wavelength)
13 D=10^(D/10);//unitless(Directivity)
14 n=D/4/dBYlambda;//no. of elements
15 disp(n,"(i) No. of elements : ");
16 LBYlambda=(n-1)*dBYlambda;//(length/wavelength)
17 disp("(ii) Length of the array is "+string(LBYlambda
     )+"*lambda");
18 HPBW=2*acosd(1-1.391/%pi/n/dBYlambda);//degree(HPBW)
```

```
19 disp(HPBW,"(iii) HPBW in degree : ");
20 SLL=-13.46;//dB(Side lobe level)
21 disp(SLL,"(iv) SLL in dB : ");
22 Beta_into_lambda=2*%pi;
23 //alfa=-Beta*d;//for theta=0
24 //alfa=Beta*d;//for theta=180
25 alfa1=-Beta_into_lambda*dBYlambda;//radian////for
     theta=0
26 alfa1=alfa1*180/%pi;//degree(angle)
27 alfa2=Beta_into_lambda*dBYlambda;//radian////for
     theta=180
28 alfa2=alfa2*180/%pi;//degree(angle)
29 disp(alfa2,alfa1,"(v) Progressive phase shift,
     for theta equals to 0  & 180  are : ");
```

Experiment: 4

Design of Equiangular Spiral Antenna

Scilab code Solution 4.4 Ex4

```
1  //Design of Equiangular spiral antenna
2  //Windows 10
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  format('v',5);
10 fU=900;//MHz(Upper frequency)
11 fL=450;//MHz(Lower frequency)
12 c=3*10^8;//m/s(Speed of light)
13 lambdaU=c/(fU*10^6);//m(Upper wavelength)
14 lambdaL=c/(fL*10^6);//m(Lower wavelength)
15 Exp_ratio=4;//expansion ratio
16 a=log(Exp_ratio)/(2*%pi);//rad^-1////rate of spiral
17 Beta=atand(1/a);//degree
18 r0=lambdaU/4;//meter////minimum radius
19 disp(r0*100,"Minimum radius in cm : ");
```

```
20 R=lambdaL/4;//meter////minimum radius
21 disp(R*100,"Maximum radius in cm : ");
22 fi_m=log(R/r0)/a;//radian
23 fi_m=fi_m*180/%pi;//degree
24 disp(fi_m," m  in degree is ");
25 N=1/2;//for  m =180;//degree
26 disp(N,"Number of turns, N is  ");
```

Experiment: 5

Design of Log Periodic Dipole

Scilab code Solution 5.5 Ex5

```
1  //Design of log periodic dipole
2  //Windows 10
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  format('v',7);
10 tau=0.895;//scale factor
11 sigma=0.17;//(spacing factor)
12 fU=30;//MHz(Upper frequency)
13 fL=10;//MHz(Lower frequency)
14 c=3*10^8;//m/s(Speed of light)
15 lambdaU=c/(fU*10^6);//m(Upper wavelength)
16 lambdaL=c/(fL*10^6);//m(Lower wavelength)
17 l1=lambdaU/2;//m(Length of shortest element)
18 disp(l1,"Length of shortest element, l1 in meter is
       : ");
19 l2=l1/tau;l3=l2/tau;l4=l3/tau;l4=l3/tau;l5=l4/tau;l6
     =l5/tau;l7=l6/tau;l8=l7/tau;l9=l8/tau;l10=l9/tau;
```

```
    l11=l10/tau;//m(Length of element)
20 disp(l11,l10,l9,l8,l7,l6,l5,l4,l3,l2,"Other elements
    length(m) l2, l3, l4, l5, l6, l7, l8, l9, l10,
    l11 are :");
21 alfa=18.07;//degree(angle)
22 R1=(l1/2)/tand(alfa/2);//m(Spacing between elements)
23 R2=R1/tau;R3=R2/tau;R4=R3/tau;R4=R3/tau;R5=R4/tau;R6
    =R5/tau;R7=R6/tau;R8=R7/tau;R9=R8/tau;R10=R9/tau;
    R11=R10/tau;//m
24 disp(R11,R10,R9,R8,R7,R6,R5,R4,R3,R2,R1,"Spacing
    between elements in meter R1, R2, R3, R4, R5, R6,
    R7, R8,R9, R10, R11 are :");
```

Experiment: 6

Design of Rhombic Antenna

Scilab code Solution 6.6 Ex6

```
1 //Design of rhombic antenna
2 //Windows 10
3 //Scilab 6.0.0
4
5 clc;
6 clear;
7 close;
8
9 f=20 //frequency in MHz
10 f=20*10^6 // frequency in Hz
11 c=3*10^8 //speed of light in m/s
12 lambda=c/f //wavelength in meter
13 Delta=10 // angle of elevation in Degrees
14 H=lambda/(4*sind(Delta)) // Rhombic height in m
15 phi=90-Delta // tilt angle in Degrees
16 l=lambda/(2*(cosd(phi)^2)) // wire length in m
17 disp(H," Rhombic height in m:")
18 disp(phi,"Tilt angle in Degrees:")
19 disp(l,"length of wire in meter:")
```

Experiment: 7

Design of 3 element of Yagi Uda Antenna

Scilab code Solution 7.7 Ex7

```
1 //Design of 3 element yagi uda antenna
2 //Windows 10
3 //Scilab 6.0.0
4
5 clc;
6 clear;
7 close;
8
9 f_MHz=172 // frequency in MHz
10 c=3*10^8 // speed of light in m/s
11 lambda=c/f_MHz // wavelength in m
12 La=478/f_MHz // length of driven element in feet
13 Lr=492/f_MHz // length of reflector in feet
14 Ld=461.5/f_MHz // length of director in feet
15 S=142/f_MHz // element spacing in feet
16 disp(La,"length of driven element in feet:")
17 disp(Lr,"length of reflector in feet:")
18 disp(Ld,"length of director in feet:")
19 disp(S,"element spacing in feet:")
```

Experiment: 8

Design of 6 element of Yagi Uda Antenna

Scilab code Solution 8.8 Ex8

```
1 //Design of 6 element yagi uda antenna
2 //Windows 10
3 //Scilab 6.0.0
4
5 clc;
6 clear;
7 close;
8
9 G=12 // required gain in dB
10 f=200 // frequency in MHz
11 f=200*10^6 // frequency in Hz
12 c=3*10^8 // speed of light in m/s
13 lambda=c/f // wavelength in m
14 La=0.46*lambda // length of driven element in m
15 Lr=0.475*lambda // length of reflector in m
16 Ld1=0.44*lambda // length of director1 in m
17 Ld2=0.43*lambda // length of director2 in m
18 Ld3=0.42*lambda // length of director3 in m
19 Ld4=0.40*lambda // length of director4 in m
```

```
20 SL=0.25*lambda // spacing between reflector and
      driver in m
21 Sd=0.31*lambda // spacing director and driving
      element in m
22 d=0.01*lambda // diameter of elements in m
23 l=1.5*lambda // length of array in m
24 disp(La,"length of driven element in m:")
25 disp(Lr,"length of reflector in m:")
26 disp(Ld1,"length of director1 in m:")
27 disp(Ld2,"length of director2 in m:")
28 disp(Ld3,"length of director3 in m:")
29 disp(Ld4,"length of director4 in m:")
30 disp(SL,"spacing between reflector and driver in m:"
      )
31 disp(Sd,"spacing director and driving element in m:"
      )
32 disp(d,"diameter of elements in m:")
33 disp(l,"length of array in m:")
```

Experiment: 9

Design of a 5 element Broad Side Array which has optimum pattern

Scilab code Solution 9.9 Ex9

```
1 //Design of a 5 element Broad Side Array which has
     optimum pattern
2 //Windows 10
3 //Scilab 6.0.0
4
5 clc;
6 clear;
7 close;
8
9 dB=20;
10 n=5;// five element array
11 r=10^(dB/20);// because dB=20log(r)
12 // Tchebyscheff polynomial of degree (n-1)=5-1=4
13 // T4(xo)=r
14 // 8xo^4-8xo^2+1=10
15 // then using alternate formula, we get the value of
     xo
```

```
16 m=4;// degree of the equation
17 a=sqrt(r^2-1);
18 A=(r+a)^(1/m);
19 B=(r-a)^(1/m);
20 xo=.5*(A+B);
21 // E5=aoz+a1(2z^2-1)+a2(8z^4-8z^2+1), where z=(x/xo)
22 // E5=T4(xo)
23 // ao(x/xo)+a1(2(x/xo)^2-1)+a2(8(x/xo)^4-8(x/xo)
      ^2+1)=8x^4-8x^2+1
24 // Now equating terms, we have
25 // a2(x/xo)^4=x^4
26 a2=xo^4;
27 // a1*2(x/xo)^2-a2*8(x/xo)^2=-8x^2
28 a1=4*a2-4*xo^2;
29 // ao-a1+a2=1
30 ao=1+a1-a2;
31 // Therefore the relative amplitude of the array are
32 a11=a1/a1;// the ratio of the a1 to a1
33 a12=a1/a2;// the ratio of the a1 to a2
34 a02=2*ao/a2;// the ratio of the 2ao to a2
35 printf("The value of the parameter r= %d", r);
36 printf("\n The value of the parameter xo= %f", xo);
37 printf("\n The value of the current amplitude
      parameter 2*ao= %f", 2*ao);
38 printf("\n The value of the current amplitude
      parameter a1= %f", a1);
39 printf("\n The value of the current amplitude
      parameter a2= %f", a2);
40 printf("\n The value of the relative amplitude
      parameter a11= %f", a11);
41 printf("\n The value of the relative amplitude
      parameter a12= %f", a12);
42 printf("\n The value of the relative amplitude
      parameter a02= %f", a02);
```

Experiment: 10

Four Patch Array

Scilab code Solution 10.10 Ex10

```
1  //Four-Patch Array
2  //Windows 10
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  n = 4                  //Number of patch antennas (
       lambda)
10 diameter = 0.5         //Diameter of patch antennas (
       lambda)
11 A_e = n*diameter                //Effective aperture (
       lambda^2)
12 D = (4*%pi*A_e)           //Directivity (unitless)
13 D_dbi = 10*log10(D)      //Directivity (dBi)
14 ohm_a = (4*%pi)/D         //Beam area (steradians)
15 mprintf("The directivity is %d or %d dBi",D,D_dbi)
16 mprintf("\nThe beam area is %.1f sr", ohm_a)
```