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

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List of Experiments

Experiment: 1

Design array to achieve optimum pattern

Scilab code Solution 1.1 Ex1

```
//Design array to achieve optimum pattern
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

MainBeamwidth=45;//in degree
thetaN=MainBeamwidth/2;//in degree
thetaN=thetaN*%pi/180;//in radian
m=5;//no. of elements
//d=lambda/2 in meter
x=cos(%pi/(2*(m-1)));
xo=x/cos((%pi/2)*sin(thetaN));//unitless
disp("E5=ao*z+a1*(2*z^2-1)+a2*(8*z^4-8*z^2+1)");
disp("We Know that : z=x/xo, E5=T4*xo");
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");
```

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

```
//Design array of 5 elements to achieve optimum
   pattern
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

//Side lobe level below main lobe
disp("Side lobe level below main lobe : ")
SideLobe=20;//in dB
r=10^(SideLobe/20);//
disp(r,"r=") ;
//let No. of elements =5, n=5
disp("No. of elements are 5, n=5 :");
disp("Tchebyscheff polynomials of degree (n-1) is");
disp("5-1=4");
disp("T4(xo)=r");
```

```
disp("8*xo^4-8*xo^2+1=10");
disp("By using alternate formula, we get");
m=4;
r=10;
xo=(1/2)*[(r+sqrt(r^2-1))^(1/m)+(r-sqrt(r^2-1))^(1/m)]
disp(xo,"xo=");
disp("E5=T4(xo)")
disp("E5=ao*z+a1*(2*z^2-1)+a2*(8*z^4-8*z^2+1)");
disp("We Know that : z=x/xo, E5=T4*xo");
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");
disp("By comparing the term we have : ");
disp("a2=xo^4   a1=4*a2-4*xo^2   ao=1+a1-a2 ")
a2=xo^4;
a1=4*a2-4*xo^2;
ao=1+a1-a2;
disp("And therefore the 5 elements array is given by : ");
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

```
//Design of simple End Fire Array
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

format('v',6);
D=20;//dB(Directivity)
//d=lambda/4;(spacing)
dBYlambda=1/4;//(spacing/wavelength)
D=10^(D/10);//unitless(Directivity)
n=D/4/dBYlambda;//no. of elements
disp(n,"(i) No. of elements : ");
LBYlambda=(n-1)*dBYlambda;//(length/wavelength)
disp("(ii) Length of the array is "+string(LBYlambda
   )+"*lambda");
HPBW=2*acosd(1-1.391/%pi/n/dBYlambda);//degree(HPBW)
```

```
disp(HPBW,"(iii) HPBW in degree : ");
SLL=-13.46;//dB(Side lobe level)
disp(SLL,"(iv) SLL in dB : ");
Beta_into_lambda=2*%pi;
//alfa=-Beta*d;//for theta=0
//alfa=Beta*d;//for theta=180
alfa1=-Beta_into_lambda*dBYlambda;//radian////for theta=0
alfa1=alfa1*180/%pi;//degree(angle)
alfa2=Beta_into_lambda*dBYlambda;//radian////for theta=180
alfa2=alfa2*180/%pi;//degree(angle)
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

```
//Design of Equiangular spiral antenna
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

format('v',5);
fU=900;//MHz(Upper frequency)
fL=450;//MHz(Lower frequency)
c=3*10^8;//m/s(Speed of light)
lambdaU=c/(fU*10^6);//m(Upper wavelength)
lambdaL=c/(fL*10^6);//m(Lower wavelength)
Exp_ratio=4;//expansion ratio
a=log(Exp_ratio)/(2*%pi);//rad^-1////rate of spiral
Beta=atand(1/a);//degree
r0=lambdaU/4;//meter////minimum radius
disp(r0*100,"Minimum radius in cm : ");
```

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

Experiment: 5

Design of Log Periodic Dipole

Scilab code Solution 5.5 Ex5

```
//Design of log periodic dipole
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

format('v',7);
tau=0.895;//scale factor
sigma=0.17;//(spacing factor)
fU=30;//MHz(Upper frequency)
fL=10;//MHz(Lower frequency)
c=3*10^8;//m/s(Speed of light)
lambdaU=c/(fU*10^6);//m(Upper wavelength)
lambdaL=c/(fL*10^6);//m(Lower wavelength)
l1=lambdaU/2;//m(Length of shortest element)
disp(l1,"Length of shortest element, l1 in meter is : ");
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)
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 : ");
alfa=18.07;//degree(angle)
R1=(l1/2)/tand(alfa/2);//m(Spacing between elements)
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
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

```
//Design of rhombic antenna
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

f=20 //frequency in MHz
f=20*10^6 // frequency in Hz
c=3*10^8 //speed of light in m/s
lambda=c/f //wavelength in meter
Delta=10 // angle of elevation in Degrees
H=lambda/(4*sind(Delta)) // Rhombic height in m
phi=90-Delta // tilt angle in Degrees
l=lambda/(2*(cosd(phi)^2)) // wire length in m
disp(H," Rhombic height in m:")
disp(phi,"Tilt angle in Degrees:")
disp(l,"length of wire in meter:")
```

Experiment: 7

Design of 3 element of Yagi Uda Antenna

Scilab code Solution 7.7 Ex7

```
//Design of 3 element yagi uda antenna
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

f_MHz=172 // frequency in MHz
c=3*10^8 // speed of light in m/s
lambda=c/f_MHz // wavelength in m
La=478/f_MHz // length of driven element in feet
Lr=492/f_MHz // length of reflector in feet
Ld=461.5/f_MHz // length of director in feet
S=142/f_MHz // element spacing in feet
disp(La,"length of driven element in feet:")
disp(Lr,"length of reflector in feet:")
disp(Ld,"length of director in feet:")
disp(S,"element spacing in feet:")
```

Experiment: 8

Design of 6 element of Yagi Uda Antenna

Scilab code Solution 8.8 Ex8

```
//Design of 6 element yagi uda antenna
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

G=12 // required gain in dB
f=200 // frequency in MHz
f=200*10^6 // frequency in Hz
c=3*10^8 // speed of light in m/s
lambda=c/f // wavelength in m
La=0.46*lambda // length of driven element in m
Lr=0.475*lambda // length of reflector in m
Ld1=0.44*lambda // length of director1 in m
Ld2=0.43*lambda // length of director2 in m
Ld3=0.42*lambda // length of director3 in m
Ld4=0.40*lambda // length of director4 in m
```

```
SL=0.25*lambda // spacing between reflector and
   driver in m
Sd=0.31*lambda // spacing director and driving
   element in m
d=0.01*lambda // diameter of elements in m
l=1.5*lambda // length of array in m
disp(La,"length of driven element in m:")
disp(Lr,"length of reflector in m:")
disp(Ld1,"length of director1 in m:")
disp(Ld2,"length of director2 in m:")
disp(Ld3,"length of director3 in m:")
disp(Ld4,"length of director4 in m:")
disp(SL,"spacing between reflector and driver in m:"
   )
disp(Sd,"spacing director and driving element in m:"
   )
disp(d,"diameter of elements in m:")
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

```
//Design of a 5 element Broad Side Array which has
   optimum pattern
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

dB=20;
n=5;// five element array
r=10^(dB/20);// because dB=20log(r)
// Tchebyscheff polynomial of degree (n-1)=5-1=4
// T4(xo)=r
// 8xo^4-8xo^2+1=10
// then using alternate formula, we get the value of
    xo
```

```
m=4;// degree of the equation
a=sqrt(r^2-1);
A=(r+a)^(1/m);
B=(r-a)^(1/m);
xo=.5*(A+B);
// E5=aoz+a1(2z^2-1)+a2(8z^4-8z^2+1), where z=(x/xo)
// E5=T4(xo)
// ao(x/xo)+a1(2(x/xo)^2-1)+a2(8(x/xo)^4-8(x/xo)
   ^2+1)=8x^4-8x^2+1
// Now equating terms, we have
// a2(x/xo)^4=x^4
a2=xo^4;
// a1*2(x/xo)^2-a2*8(x/xo)^2=-8x^2
a1=4*a2-4*xo^2;
// ao-a1+a2=1
ao=1+a1-a2;
// Therefore the relative amplitude of the array are
a11=a1/a1;// the ratio of the a1 to a1
a12=a1/a2;// the ratio of the a1 to a2
a02=2*ao/a2;// the ratio of the 2ao to a2
printf("The value of the parameter r= %d", r);
printf("\n The value of the parameter xo= %f", xo);
printf("\n The value of the current amplitude
   parameter 2*ao= %f", 2*ao);
printf("\n The value of the current amplitude
   parameter a1= %f", a1);
printf("\n The value of the current amplitude
   parameter a2= %f", a2);
printf("\n The value of the relative amplitude
   parameter a11= %f", a11);
printf("\n The value of the relative amplitude
   parameter a12= %f", a12);
printf("\n The value of the relative amplitude
   parameter a02= %f", a02);
```

Experiment: 10

Four Patch Array

Scilab code Solution 10.10 Ex10

```
//Four−Patch Array
//Windows 10
//Scilab 6.0.0

clc;
clear;
close;

n = 4                   //Number of patch antennas (lambda)
diameter = 0.5          //Diameter of patch antennas (lambda)
A_e = n*diameter                  //Effective aperture (lambda^2)
D = (4*%pi*A_e)          //Directivity (unitless)
D_dbi = 10*log10(D)     //Directivity (dBi)
ohm_a = (4*%pi)/D        //Beam area (steradians)
mprintf("The directivity is %d or %d dBi",D,D_dbi)
mprintf("\nThe beam area is %.1f sr", ohm_a)
```