Scilab Manual for
ANTENNA
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Experiment: 1

To design a 6-element Yagi-Uda antenna operating at 500 MHz

Scilab code Solution 1.0 Experiment Number 1

```
1 //AIM:To design 6-element Yagi-Uda antenna operating
      at 500 MHz
2 //Software version Scilab 5.5.2
3 //OS windows 7
4 clc;
5 clear;
6 frequency=500;//in MHz
7 lam=(3*10^8)/(500*10^6);//Computing the wavelength
8 disp('m',lam,"Value of the wavelength (lambda) = ");
9 //To calculate length of director and reflector from
      dipole
10 Lr=0.475*lam;// Computing the length of the
     reflector
11 disp('m',Lr,"Length of the reflector = ");
12 La=0.46*lam;// Computing the length of the dipole
13 disp('m',La,"Length of the dipole = ");
14 Ld1=0.44*lam;//Computing the lengths of the
     directors Ld1 and Ld2
15 disp('m',Ld1,"Lengths of the directors Ld1 and Ld2 =
```

```
    ");
Ld3=0.43*lam;//Computing the length of the director
    Ld3
disp('m',Ld3,"Length of the director Ld3 = ");
Ld4=0.40*lam;//Computing the length of the director
    Ld4
disp('m',Ld4,"Length of the director Ld4=");

Sr=0.25*lam;//Computing the seperation between the
    reflector and the dipole
disp('m',Sr,"Seperation between the reflector and
    the dipole");

Sd1=0.31*lam;//Computing the seperation between the
    director and the dipole
disp('m',Sd1,"Seperation between the director and
    the dipole Sd1=Sd2=Sd3=Sd4=");

//To calculate length of the Yagi-Uda antenna
Len=1.5*lam;
disp('m',Len,"Length of the Yagi-Uda antenna = ");

//To calculate diameter of Yagi-Uda antenna

diam=0.01*lam;
disp('m',diam,"The diameter of the Yagi-Uda antenna
    = ");
```

Experiment: 2

Compute the field strength of the incident wave of square loop antenna

Scilab code Solution 2.0 Experiment Number 2

```
1 //AIM:Compute the field strength of the incident
     wave of square loop antenna.
2 //Software version Scilab 5.5.2
3 //OS windows 7
4
5 clc;
6 clear;
7 //Let the square loop antenna have 25 turns and each
     side of 0.5m. When it
8 //is tuned to 500 KHz,the maximum emf induced in the
     loop is 150 uV.
9
10 N=25;// Number of turns
11 l=0.5;//Length of the side of a square loop antenna
     (in meters)
12 Vrms=150*(10^-6);// in micro Volts(uV)
13 f=500*(10^3);//Frequency in Hz
```

```
14 disp('Hz',f,"frequency=")
15 c=3*10^8;//Speed of light
16 lambda=c/f;//Computing the value of the wavelength (
     lambda)
17 disp('m',lambda,"lambda=")
18 A=l*l;//area
19 disp('m^2',A,"Area=")
20 theta=0;//as emf induced is maximum, the angle theta
     =0 degree
21 Erms=(lambda/(2*%pi*A*N*cos(theta)))*Vrms
22 disp('V/m',Erms,"The field strength of incident wave
     (Erms)=");
```

Experiment: 3

To design a pyramidal horn antenna in E-plane and H-plane

Scilab code Solution 3.0 Experiment Number 3

```
1 //AIM: To design pyramidal horn antenna in E-plane
    and H-plane.
2 //Software version Scilab 5.5.2
3 //OS windows 7
4 clear;
5 clc;
6 //Consider the E-plane aperture aE=10   is fed with
    a rectangular waveguide with
7 //TE10 mode. Let     =0.2   in the E-plane and 0.375
    in the H-plane.
8 //We will compute :
9 //(i) Length of horn antenna,H-plane aperture,flare
    angle for E-plane & H-plane.
10 //(ii) Half power beamwidth in E plane & H-plane.
11 //(iii) First null beamwidth in E-plane and H-plane.
12 //(iv) Directivity in dB
13
14 lambda=1;//Assumption
15 aE=10*lambda;
```

```
16 delE=0.2*lambda;
17 delH=0.375*lambda;
18
19 //To find the length of horn
20
21 Length=(aE*aE)/(8*delE);
22 disp('  ',Length,'Length of the horn=');
23
24 //To find the H-plane aperture
25
26 aH=sqrt(Length*8*delH);
27 disp('  ',aH,'aH=');
28
29 //To compute flare angles theta_E and theta_H
30 // We require the values of aE/2 and aH/2
31
32 b=(aE/2)/Length;
33 c=(aH/2)/Length;
34 e=2*(atan(b))*180/3.14;
35 disp('degrees',e,"thetha_E in degree=");
36
37 f=2*(atan(c))*180/3.14;
38 disp('degrees',f,"thetha_H in degree=");
39
40 //To calculate half power beamwidth in both planes
41
42 HPBWE=56/aE;
43 disp('degrees',HPBWE,"HPBW(E-plane) in degree=");
44
45 HPBWH=67/aH;
46 disp('degrees',HPBWH,"HPBW(H-plane) in degree=");
47
48 // To calculate first null beamwidth in both planes
49
50 FNBWE=115/aE;
51 disp('degrees',FNBWE,"FNBW(E-plane) in degree=");
52
53 FNBWH=172/aH;
```

```
54 disp('degrees',FNBWH,"FNBW(H-plane) in degree=");
55
56 //To calculate Directivity
57
58 Ap=aE*aH;
59 disp('  ^2',Ap,"Directivity Ap=");
60
61 D=10*log10(7.5*Ap);
62 disp('dB',D,"Directivity Ap in dB=");
```

Experiment: 4

Compute the parameter (power) of the receiving antenna for polarization match condition.

Scilab code Solution 4.0 Experiment Number 4

```
1 //AIM: Compute the parameter(power) of the receiving
      antenna for polarization
2 //match condition
3 //Software version Scilab 5.5.2
4 //OS windows 7
5
6 clc;
7 clear;
8 //Assume that the transmitting and receiving
     antennas are operating at 3GHz
9 //with gain 25dB and 20dB respectively,transmitter
     power is 100 Watts
10 //and the distance between the antennas is 500 m
11 f=3*(10^9);//in GHz
12 disp('Hz',f,"Frequency=")
```

```
13 c=3*(10^8);//in m/s
14 lambda=c/f;//in meters
15 disp('m',lambda,"lambda=")
16 r=500;//in meters
17 Pt=100;// in Watts
18 Gtdb=25;//in dB
19 Grdb=20;//in dB
20 Gt=10^(Gtdb/10);
21 disp(Gt,"Gt=")
22 Gr=10^(Grdb/10);
23 disp(Gr,"Gr=")
24 PLF=1;//Polarization match.
25 Pr=Pt*((lambda/(4*%pi*r))^2)*Gt*Gr*(PLF^2);
26 disp('W',Pr,"Power delivered to the receiver =")
```

Experiment: 5

Design a lossless horn antenna with directivity 20dB at a frequency of 10 GHz

Scilab code Solution 5.0 Experiment Number 5

```
1 //AIM: Design a lossless horn antenna with
     directivity 20dB at a frequency of 10 GHz
2 //Software version Scilab 5.5.2
3 //OS windows 7
4 clc;
5 clear;
6 //We will calculate :
7 //1. the maximum effective aperture
8 //2. the maximum power received when incident power
     density is 2*10^-3(W/m^2)
9 clc;
10 f=10*10^9;//Frequency
11 c=3*10^8;//Speed of light
12 Do=20;//Directivity (in dB)
13 do=10^(Do/10)
14 disp(do,"Dimensionless directivity=")
15 lambda=c/f;//Computing the wavelength
```

```
disp('m',lambda,"lambda=")
//Computing the maximum effective aperture Aem :
Aem=((lambda^2)*do)/(4*%pi);
disp('m^2',Aem,"Maximum effective aperture,Aem=")
//Computing the maximum power received: Pr
disp('Hz',f,"Frequency=")
Wi=2*10^-3;//Incident power density
Pr=Aem*Wi;
disp('W',Pr,"Maximum power received, Pr=")
```

Experiment: 6

To design a broadside array.

Scilab code Solution 6.0 Experiment Number 6

```
1 //AIM:To design a broadside array
2 //Software version Scilab 5.5.2
3 //OS windows 7
4
5 clc;
6 //We will consider an array of four isotropic
     sources along z-axis separated by
7 // a distance of lambda/2 and a progressive phase
     shift alpha=0
8 //We will find:
9 //i)Null direction.
10 //ii)Direction to maxima.
11 //iii)Directions of sidelobe maxima.
12 //iv)Half power beamwidth.
13 //v)First null beam width.
14 //vi)Side lobe level.
15
16 clear;
17 //for ease of calculation taking lambda=1
18 lambda=1;
19 d=lambda/2;
```

```
20 n=4;//Since 4 isotropic point sources
21 alpha=0;//alpha=0 indicates broadside case
22 //(i) :To find Null direction
23 //For N=1
24 N=1;
25 ithetha01=int(acos(-N/2)*180/3.14);
26 thetha01=int(acos(N/2)*180/3.14);
27 //And for N=2
28 N=2;
29 ithetha02=int(acos(-N/2)*180/3.14);
30 thetha02=int(acos(N/2)*180/3.14);
31 disp('degrees',ithetha01,'degrees',thetha01,"Null
      direction for N=1 are ");
32 disp('degrees',ithetha02,'degrees',thetha02,"Null
      direction for N=2 are ");
33
34 //Taking N=3 onwards is not possible since N/2 is
      greater than 1 whose cos
35 //inverse can not be determed
36
37 //(ii) : Calculating Directions of maxima:ithetham=
      acos(+-m*lam/d)
38 //taking m=0
39 m=0;
40 //hence
41 ithetham=acos(-0)*(180/3.14);
42 thetham=acos(0)*(180/3.14);
43 disp('degrees',thetham,'degrees',ithetham,"theta_m="
      );
44
45 //(iii) : Side lobe maxima:
46 //thethas=acos(+-((2s+1) /(2nd)) for S=1,2,....
47 //For S=1
48 S=1;
49 a=[(2*S+1)*lambda]/(2*n*d);
50 disp(a,'a=')
51 ithethas=acos(-a)*(180/3.14);
52 thethas=acos(a)*(180/3.14);
```

```
53 disp('degrees',ithethas,'degrees',thethas,"lobe
      maxima=");
54 //Values for S=2 onwards cannot be determined
55
56 //(iv) : Half power beamwidth.
57 //HPBW=2*(pi/2-acos((1.391*lam)/(pi*n*d))   hence
58 HPBW=2*(3.14/2-(acos(2*(1.391)/(4*3.14))))*180/3.14;
59 disp('degrees',HPBW,'HPBW=')
60
61 //(v) : First null beam width.
62 //FNBW=2*(3.14/2-acos((lam/(4*lam/2))
63 FNBW=2*(3.14/2-acos(2/n))*180/3.14;
64 disp('degrees',FNBW,'FNBW=')
65
66 //Side lobe level=((Maximum value of largest side
      lobe)/(Maximum value of major lobe))
67 SLL=20*log10(2/(3*3.14));
68 disp('dB',SLL,"Side lobe level (SLL)=");
```

Experiment: 7

Design a five turn helical antenna in the normal mode at 400MHz

Scilab code Solution 7.0 Experiment Number 7

```
1 //AIM: Design a five turn helical antenna in the
     normal mode at 400MHz.
2 //Software version Scilab 5.5.2
3 //OS windows 7
4 clc;
5 clear;
6 //We consider that the spacing between the turns is
       /50 and assume that
7 //circular polarization is desired.
8 //We will determine
9 // 1. Circumference of the helix(in meters)
10 //2. Length of a single turn
11 //3. Overall length of the entire helix
12 //4. Pitch angle in degrees
13
14 n=5;//Number of turns
15 f=400*10^6;//Frequency
```

```
16 disp('Hz',f,"Frequency=")
17 c=3*10^8;//Speed of light
18 lambda=c/f;//Computing the wavelength
19 disp('m',lambda,"lambda=");
20 //Computing the vertical separation (spacing)
     between the turns
21 //Spacing(S)=(wavelength)/(No. of turns)
22 S=lambda/50;
23 disp('m',S,"Spacing=");
24 C=sqrt(2*lambda*S);//Circumference
25 disp('m',C,"Circumference=");
26 L0=sqrt((S^2)+(C^2));//Length of single turn
27 disp('m',L0,"Length of single turn (L0)=")
28 Ln=n*L0;//Overall length
29 disp('m',Ln,"Overall length(Ln)=")
30 alpha=atan(S/C);//Pitch angle(in radians)
31 alpha_degrees=alpha*(180/%pi);//Pitch angle(in
     degrees)
32 disp('degrees',alpha_degrees,"Pitch angle=")
```

Experiment: 8

Compute the minimum transmitter power of microwave repeater operating at 10 GHz

Scilab code Solution 8.0 Experiment Number 8

```
1 //AIM:Find the minimum transmitter power of
    microwave repeater operating
2 //at 10 GHz.
3 //Software version Scilab 5.5.2
4 //OS windows 7
5
6 clc;
7 clear;
8 //Let a series of microwave repeater links operate
    at 10 GHz and are
9 //used to relay television signals into a valley
    that is surrounded by
10 //steep mountain ranges. Each repeater consists of a
     transmitter,
11 //receiver antennas and associated equipment. The
    transmitting
12 // and receving antennas are identical horns with
```

```
    gain of 15 dB each.
13 //The repeaters are separated by 10 km. For
    acceptable signal to noise
14 //ratio, the power received at each repeater must be
     greater than 10 nW.
15 //Loss due to ploarization mismatch should not
    exceed 3dB. Assuming
16 //matched loads,we will compute the minimum
    transmitter power that should
17 //be used.
18 f=10*10^9;//Frequency
19 c=3*10^8;//Speed of light
20 Pr=10*10^-9;
21 lambda=c/f;//Computing the wavelength
22 disp('m',lambda,"Wavelength=")
23 Gdb=15;//(in dB)
24 G=10^(Gdb/10);
25 Gt=G;
26 Gr=G;
27 disp(Gt,"Gt=")
28 disp(Gr,"Gr=")
29 r=10*10^3;
30 adb=-3//in dB
31 a=10^(adb/10);
32 disp(a,"|aT*aR|^2=")
33 PLF=sqrt(a)
34 disp(PLF,"Dimensionless polarization loss factor(PLF
    )=")
35 b=(((lambda/(4*%pi*r))^2)*Gt*Gr*a);//b means
    calculation of Pr/Pt
36 disp(b,"Pr/Pt=")
37 Pt=Pr/b;
38 disp('W',Pt,"Minimum transmitter power=")
```

Experiment: 9

Design a rectangular microstrip antenna whose centre frequency is 2.4GHz

Scilab code Solution 9.0 Experiment Number 9

```
1  //AIM: Design a rectangular microstrip antenna whose
       centre frequency is 2.4 GHz.
2  //Software version Scilab 5.5.2
3  //OS windows 7
4  clc;
5  clear;
6
7  fr=2.4*(10^9);
8  Er=4.4;//Dielectric constant of the substrate
9  h=1.6*(10^-3);//Height of the substrate
10 vo=3*(10^8);
11 W=(vo/(2*fr))*((2/(Er+1))^(1/2));
12 disp('m',W,"Width of patch=");
13 Ereff=((Er+1)/2)+(((Er-1)/2)*((1+12*(h/W)))^(-0.5));
14 disp(Ereff,"Ereff=");
15 x=W/h;
16 disp(x,"W/h=");
```

```
17 dL=((h*0.412)*(Ereff+0.3)*(x+0.264))/((Ereff-0.258)
      *(x+0.8));
18 disp('m',dL,"dL=");
19 L=(vo/(2*fr*(Ereff^0.5)))-(2*dL);
20 disp('m',L,"Length of patch=");
```

Experiment: 10

To find the radiation efficiency in percentage of a single turn and 8 turns of small circular loop antenna

Scilab code Solution 10.0 Experiment Number 10

```
1 //AIM:To find the radiation efficiency in percentage
      of a single turn and 8 turns of small circular
    loop antenna.
2 //Software version Scilab 5.5.2
3 //OS windows 7
4 //Assume f=100MHz.The radius of the loop is a=  /25,
      the radius of wire
5 //is (d/2)=(10^-4)*   and the turns are spaced
    4*(10^-4)   apart.Assume the wire of
6 //copper(sigma=5.7*(10^7) S/m) and the antenna is
    radiating in free space.
7 clc;
8 clear;
9 c=3*10^8;
10 f=100;//in MHz
```

```
11 lambda=c/(f*10^6);
12 disp('m',lambda,"  =");
13 a=lambda/25;
14 disp('m',a,"radius=");
15 C=2*(%pi)*a;
16 disp(C,"circumference=");
17 d=(2*(10^(-4)))*lambda;//d is the diameter of the
      wire
18 disp('m',d,"diameter of wire=");
19 for N=list(1,8);//for single turn loop:N=1,8.
20 x=3430/((C^3)*(f^3.5)*N*d);//here x=RL/Rr
21 K=(1/(1+(x)))*100;
22 disp(N,"For N=");
23 disp(x,"RL/Rr=");
24 disp('%',K,"K=");
25 end;
```

Experiment: 11

Determination of voltage induced in a loop antenna that has 12 turns

Scilab code Solution 11.0 Experiment Number 11

```
1 //AIM: Determination of  voltage induced in a loop
     antenna that has 12 turns.
2 //Software version Scilab 5.5.2
3 //OS Windows 7
4 clc;
5 clear;
6
7 //Let the field strength of the incident waves be
     100 uV/m & frequency of 10 MHz.
8 //The loop is oriented such that its plane is in the
      direction of waves.
9 //Assume area is 1 (metre)^2
10
11 N=12;// Number of turns
12 f=10*(10^6);//Frequency in Hz
13 disp('Hz',f,"Frequency=")
14 c=3*10^8;//Speed of light
```

```
15 lambda=c/f;//Wavelength in metres
16 disp('m',lambda,"Wavelength (lambda)=");
17 A=1;//Area in m^2
18 Erms=100*(10^(-6));// in uV/m
19 theta=0;//as plane of loop is in the direction of
      wave angle is 0 degree
20 Vrms=((2*%pi*A*N.*cos(theta))/lambda)*Erms
21 disp('V/m',Vrms,"Vrms=");
```

Experiment: 12

Find the power delivered to the receiver using Friis Transmission formula

Scilab code Solution 12.0 Experiment Number 12

```
1 //AIM:Find the power delivered to the receiver using
      Friis Transmission formula.
2 //Software version Scilab 5.5.2
3 //OS windows 7
4
5 clc;
6 clear;
7 Pt=15;//Transmitter power
8 Aet=0.2;//Effective aperture of the transmitting
     antenna
9 Aer=0.5;//Effective aperture of the receiving
     antenna
10 f=5*(10^9);//Frequency
11 disp('Hz',f,"Frequency=");
12 c=3*(10^8);//Speed of light
13 lambda=c/f;//Computing the wavelength
14 disp(lambda,"Wavelength (lambda)=");
```

```
15 r=15*(10^3);//Distance between the transmitting &
     the receiving antennas
16 disp('m',r,"Distance between transmitting & the
     receiving antennas =");
17 Pr=Pt*((Aet*Aer)/((r^2)*(lambda^2)));//Friis
     transmission formula
18 disp('Watts',Pr,"Power delivered to the receiver = "
     );
```