Scilab Manual for
ANTENNA
by Prof RAJIV TAWDE
Others
Padmabhushan Vasantdada Patil Pratishthan's College of Engineering,Mumbai University[1]

Solutions provided by
Mr Shailesh Bakshi
Others
Mumbai University/PVPP College of Engineering

June 2, 2025

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Scilab Manual and Scilab codes written in it can be downloaded from the "Migrated Labs" section at the website http://scilab.in

Contents

List of Experiments

Experiment: 1

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

Scilab code Solution 1.0 Experiment Number 1

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

```
//AIM:Compute the field strength of the incident
   wave of square loop antenna.
//Software version Scilab 5.5.2
//OS windows 7

clc;
clear;
//Let the square loop antenna have 25 turns and each
    side of 0.5m. When it
//is tuned to 500 KHz,the maximum emf induced in the
    loop is 150 uV.

N=25;// Number of turns
l=0.5;//Length of the side of a square loop antenna
   (in meters)
Vrms=150*(10^-6);// in micro Volts(uV)
f=500*(10^3);//Frequency in Hz
```

```
disp('Hz',f,"frequency=")
c=3*10^8;//Speed of light
lambda=c/f;//Computing the value of the wavelength (
    lambda)
disp('m',lambda,"lambda=")
A=l*l;//area
disp('m^2',A,"Area=")
theta=0;//as emf induced is maximum, the angle theta
    =0 degree
Erms=(lambda/(2*%pi*A*N*cos(theta)))*Vrms
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

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

lambda=1;//Assumption
aE=10*lambda;
```

```
delE=0.2*lambda;
delH=0.375*lambda;

//To find the length of horn

Length=(aE*aE)/(8*delE);
disp('  ',Length,'Length of the horn=');

//To find the H-plane aperture

aH=sqrt(Length*8*delH);
disp('  ',aH,'aH=');

//To compute flare angles theta_E and theta_H
// We require the values of aE/2 and aH/2

b=(aE/2)/Length;
c=(aH/2)/Length;
e=2*(atan(b))*180/3.14;
disp('degrees',e,"thetha_E in degree=");

f=2*(atan(c))*180/3.14;
disp('degrees',f,"thetha_H in degree=");

//To calculate half power beamwidth in both planes

HPBWE=56/aE;
disp('degrees',HPBWE,"HPBW(E-plane) in degree=");

HPBWH=67/aH;
disp('degrees',HPBWH,"HPBW(H-plane) in degree=");

// To calculate first null beamwidth in both planes

FNBWE=115/aE;
disp('degrees',FNBWE,"FNBW(E-plane) in degree=");

FNBWH=172/aH;
```

```
disp('degrees',FNBWH,"FNBW(H-plane) in degree=");

//To calculate Directivity

Ap=aE*aH;
disp('  ^2',Ap,"Directivity Ap=");

D=10*log10(7.5*Ap);
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

```
//AIM: Compute the parameter(power) of the receiving
    antenna for polarization
//match condition
//Software version Scilab 5.5.2
//OS windows 7

clc;
clear;
//Assume that the transmitting and receiving
   antennas are operating at 3GHz
//with gain 25dB and 20dB respectively,transmitter
   power is 100 Watts
//and the distance between the antennas is 500 m
f=3*(10^9);//in GHz
disp('Hz',f,"Frequency=")
```

```
c=3*(10^8);//in m/s
lambda=c/f;//in meters
disp('m',lambda,"lambda=")
r=500;//in meters
Pt=100;// in Watts
Gtdb=25;//in dB
Grdb=20;//in dB
Gt=10^(Gtdb/10);
disp(Gt,"Gt=")
Gr=10^(Grdb/10);
disp(Gr,"Gr=")
PLF=1;//Polarization match.
Pr=Pt*((lambda/(4*%pi*r))^2)*Gt*Gr*(PLF^2);
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

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

```
//AIM:To design a broadside array
//Software version Scilab 5.5.2
//OS windows 7

clc;
//We will consider an array of four isotropic
    sources along z-axis separated by
// a distance of lambda/2 and a progressive phase
    shift alpha=0
//We will find:
//i)Null direction.
//ii)Direction to maxima.
//iii)Directions of sidelobe maxima.
//iv)Half power beamwidth.
//v)First null beam width.
//vi)Side lobe level.

clear;
//for ease of calculation taking lambda=1
lambda=1;
d=lambda/2;
```

```
n=4;//Since 4 isotropic point sources
alpha=0;//alpha=0 indicates broadside case
//(i) :To find Null direction
//For N=1
N=1;
ithetha01=int(acos(-N/2)*180/3.14);
thetha01=int(acos(N/2)*180/3.14);
//And for N=2
N=2;
ithetha02=int(acos(-N/2)*180/3.14);
thetha02=int(acos(N/2)*180/3.14);
disp('degrees',ithetha01,'degrees',thetha01,"Null
    direction for N=1 are ");
disp('degrees',ithetha02,'degrees',thetha02,"Null
    direction for N=2 are ");

//Taking N=3 onwards is not possible since N/2 is
    greater than 1 whose cos
//inverse can not be determed

//(ii) : Calculating Directions of maxima:ithetham=
    acos(+-m*lam/d)
//taking m=0
m=0;
//hence
ithetham=acos(-0)*(180/3.14);
thetham=acos(0)*(180/3.14);
disp('degrees',thetham,'degrees',ithetham,"theta_m="
    );

//(iii) : Side lobe maxima:
//thethas=acos(+-((2s+1)  /(2nd))    for S=1,2,....
//For S=1
S=1;
a=[(2*S+1)*lambda]/(2*n*d);
disp(a,'a=')
ithethas=acos(-a)*(180/3.14);
thethas=acos(a)*(180/3.14);
```

```
disp('degrees',ithethas,'degrees',thethas,"lobe
   maxima=");
//Values for S=2 onwards cannot be determined

//(iv) : Half power beamwidth.
//HPBW=2*(pi/2-acos((1.391*lam)/(pi*n*d))    hence
HPBW=2*(3.14/2-(acos(2*(1.391)/(4*3.14))))*180/3.14;
disp('degrees',HPBW,'HPBW=')

//(v) : First null beam width.
//FNBW=2*(3.14/2-acos((lam/(4*lam/2))
FNBW=2*(3.14/2-acos(2/n))*180/3.14;
disp('degrees',FNBW,'FNBW=')

//Side lobe level=((Maximum value of largest side
   lobe)/(Maximum value of major lobe))
SLL=20*log10(2/(3*3.14));
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

```
//AIM:Design a five turn helical antenna in the normal mode at 400MHz.
//Software version Scilab 5.5.2
//OS windows 7
clc;
clear;
//We consider that the spacing between the turns is /50 and assume that
//circular polarization is desired.
//We will determine
// 1. Circumference of the helix(in meters)
//2. Length of a single turn
//3. Overall length of the entire helix
//4. Pitch angle in degrees

n=5;//Number of turns
f=400*10^6;//Frequency
```

```
disp('Hz',f,"Frequency=")
c=3*10^8;//Speed of light
lambda=c/f;//Computing the wavelength
disp('m',lambda,"lambda=");
//Computing the vertical separation (spacing)
    between the turns
//Spacing(S)=(wavelength)/(No. of turns)
S=lambda/50;
disp('m',S,"Spacing=");
C=sqrt(2*lambda*S);//Circumference
disp('m',C,"Circumference=");
L0=sqrt((S^2)+(C^2));//Length of single turn
disp('m',L0,"Length of single turn (L0)=")
Ln=n*L0;//Overall length
disp('m',Ln,"Overall length(Ln)=")
alpha=atan(S/C);//Pitch angle(in radians)
alpha_degrees=alpha*(180/%pi);//Pitch angle(in
    degrees)
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

```
//AIM:Find the minimum transmitter power of
   microwave repeater operating
//at 10 GHz.
//Software version Scilab 5.5.2
//OS windows 7

clc;
clear;
//Let a series of microwave repeater links operate
   at 10 GHz and are
//used to relay television signals into a valley
   that is surrounded by
//steep mountain ranges. Each repeater consists of a
    transmitter,
//receiver antennas and associated equipment. The
   transmitting
// and receving antennas are identical horns with
```

```
gain of 15 dB each.
//The repeaters are separated by 10 km. For acceptable signal to noise
//ratio, the power received at each repeater must be greater than 10 nW.
//Loss due to ploarization mismatch should not exceed 3dB. Assuming
//matched loads,we will compute the minimum transmitter power that should
//be used.
f=10*10^9;//Frequency
c=3*10^8;//Speed of light
Pr=10*10^-9;
lambda=c/f;//Computing the wavelength
disp('m',lambda,"Wavelength=")
Gdb=15;//(in dB)
G=10^(Gdb/10);
Gt=G;
Gr=G;
disp(Gt,"Gt=")
disp(Gr,"Gr=")
r=10*10^3;
adb=-3//in dB
a=10^(adb/10);
disp(a,"|aT*aR|^2=")
PLF=sqrt(a)
disp(PLF,"Dimensionless polarization loss factor(PLF)=")
b=(((lambda/(4*%pi*r))^2)*Gt*Gr*a);//b means calculation of Pr/Pt
disp(b,"Pr/Pt=")
Pt=Pr/b;
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

```
//AIM: Design a rectangular microstrip antenna whose
    centre frequency is 2.4 GHz.
//Software version Scilab 5.5.2
//OS windows 7
clc;
clear;

fr=2.4*(10^9);
Er=4.4;//Dielectric constant of the substrate
h=1.6*(10^-3);//Height of the substrate
vo=3*(10^8);
W=(vo/(2*fr))*((2/(Er+1))^(1/2));
disp('m',W,"Width of patch=");
Ereff=((Er+1)/2)+(((Er-1)/2)*((1+12*(h/W)))^(-0.5));
disp(Ereff," Ereff=");
x=W/h;
disp(x,"W/h=");
```

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

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

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

Experiment: 11

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

Scilab code Solution 11.0 Experiment Number 11

```
//AIM:Determination of  voltage induced in a loop
   antenna that has 12 turns.
//Software version Scilab 5.5.2
//OS Windows 7
clc;
clear;

//Let the field strength of the incident waves be
   100 uV/m & frequency of 10 MHz.
//The loop is oriented such that its plane is in the
    direction of waves.
//Assume area is 1 (metre)^2

N=12;// Number of turns
f=10*(10^6);//Frequency in Hz
disp('Hz',f,"Frequency=")
c=3*10^8;//Speed of light
```

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

```
//AIM:Find the power delivered to the receiver using
    Friis Transmission formula.
//Software version Scilab 5.5.2
//OS windows 7

clc;
clear;
Pt=15;//Transmitter power
Aet=0.2;//Effective aperture of the transmitting
    antenna
Aer=0.5;//Effective aperture of the receiving
    antenna
f=5*(10^9);//Frequency
disp('Hz',f,"Frequency=");
c=3*(10^8);//Speed of light
lambda=c/f;//Computing the wavelength
disp(lambda,"Wavelength (lambda)=");
```

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