Scilab Textbook Companion for Antenna and Wave Propogation by U. A. Bakshi and A. V. Bakshi[1]

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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Chapter 2

Antenna Fundamentals

Scilab code Exa 2.1 Etheta calculation

```
//chapter 2
//formula is Etheta=60*pi*I(dl/lambda)*(sin(theta)/r
    ) where thetha=90
printf("\n");
r=200;
printf("distance between points is %dm",r);
lam=10;
printf("\nthe wavelength is %dm",lam);
idl=3*10^-4;
printf("\nthe current element is %eA/m",idl);
Etheta=60*3.14*3*10^-3/2;
printf("\nEtheta is value is %eV/m",Etheta);
```

Scilab code Exa 2.2 Directive gain calculation

```
//chapter 2
//formula etta=Prad/Prad+Ploss=Rrad/Rrad+Rloss
printf("\n");
```

```
Rrad=72;
printf("radiation resistance is %dohm",Rrad);
Rloss=8;
ettar=72/(72+8);
printf("\nthe Loss resistance is %dohm",Rloss);
Gpmax=30;
printf("\nthe power gain of antenna is %d",Gpmax);
Gdmax=Gpmax/ettar;
Gdmax1=10 *log10(Gdmax);//in db
printf("\nthe Directivity gain is %g",Gdmax);
printf("\nthe Directivity gain in db is given by %edb",Gdmax1);
```

Scilab code Exa 2.3 Radiation Resistance calculation

```
//chapter 2
//Rrad=80*pi^2*(dl/lambda)^2
printf("\n");
dl=0.1;
printf("the elemental length is given by %g",dl);
Rrad=80*(%pi)^2*(0.1)^2;
printf("\nthe radiation resistance is %gohm",Rrad);
```

Scilab code Exa 2.4 Rms current calculation

```
//chapter 2
//Prad=80*(pi)^2*(dl/lambda)*(Irms)^2;
printf("\n");
frequency=100*10^6;
lamda=(3*10^8)/(100*10^6);//lamda=c/f;
printf("the wavelength is %dm",lamda);
Prad=100;
printf("\nthe Radiated power is %dW",Prad);
```

```
dl=0.01;
printf("\nthe elemental length is %gm",dl);
Irms2=(3/0.01)^2*100/(80*(%pi)^2);
Irms=sqrt(Irms2);
printf("\nthe Irms current is %gA",Irms)
```

Scilab code Exa 2.5 Effective aperture calculation

```
//chapter 2
//Pavg=0.5*|E|^2/etta0,Prmax=2*10^-6W,Aem=Prmax/Pavg
printf("\n");
E=50*10^-3;
Etta0=120*(%pi);
printf("the electric field is %eV/m",E);
Pavg=0.5*(50*10^-3)^2/(120*(%pi));
printf("\nthe average power is %gW",Pavg);
Aem=(2*10^-6)/(3.315*10^-6);
printf("\nthe maximum effective aperture area is %gm
    ^2",Aem);
```

Scilab code Exa 2.6 Aperture area calculation

```
//chapter 2
//Pavg=0.5*|E|^2/etta0,Prmax=2*10^-6W,Aem=Prmax/Pavg
printf("\n");
E=50*10^-3;
Etta0=120*(%pi);
printf("the electric field is %eV/m",E);
Pavg=0.5*(50*10^-3)^2/(120*(%pi));
printf("\nthe average power is %gW",Pavg);
Aem=(2*10^-6)/(3.315*10^-6);
printf("\nthe maximum effective aperture area is %gm
    ^2",Aem);
```

Scilab code Exa 2.7 Transmitted power calculation

```
//chapter 2
//GT=GR=Antilog[GT or Gr(in db)/10]=31.622*10^3
//1 mile=1609.35 m
printf("\n");
freq=3*10^9;
d=48280.5;//30miles*1609.35
lamda=(3*10^8)/(3*10^9);
printf("the wavelength is %gm",lamda);
Pt=(10^-3)*((4*(%pi)*48280.5)/0.1)^2*(1/(31.622*10^3)^2);//Pr=Pt(GR*GT*(lamda/4*pi*d)^2),Pr=1mW
printf("\nthe transmitter power is %gW",Pt);
```

Scilab code Exa 2.8 Noise temperature calculation

```
//chapter 2
//T0=290k,room temperature
printf("\n");
F=1.2882;
printf("given F is given by %g",F);
Te=(1.2882-1)*290;//Te=(F-1)T0
printf("\neffective noise temperature is %gK",Te);
```

Scilab code Exa 2.9 Average power calculation

```
//chapter 2
//Etheta=60Im/r*(cos(pi/2cos(theta))/sin(theta));
```

```
//theta=90
//Pavg=Rrad*Irms^2;
//Irms=Im/sqrt(2)
printf("\n");
Im=100*10^-3;
r=100
Etheta=(60*10^-3);
H=(60*10^-3)/(120*(%pi));
Pavg=73*(10^-1/sqrt(2))^2;//Rrad=73ohm for half wave
    dipole
printf("the average power is %gW",Pavg);
```

Scilab code Exa 2.10 Average power calculation

```
//chapter 2
//Rrad=36.5ohm
//Irms=Im/sqrt(2)
printf("\n");
Im=1.22;//on applying Kvl
Pavg=36.5*(1.122/sqrt(2))^2;
printf("the average power is %gW",Pavg);
```

Scilab code Exa 2.11 power calculation

```
//chapter 2
//Hphi=Im*dl*sin(theta)/(2*lamda*r);
//for Hertzian Dipole
printf("\n");
Hphi=5*10^-6;
lamda=1;//assume
dl=0.04;
Im=(5*10^-6)*2*(2*10^3)/(0.04);
Irms=Im/(sqrt(2));
```

```
Prad=80*(%pi)^2*(0.04)^2*(Irms)^2;
printf("the radiated Power is %gW",Prad);
```

Scilab code Exa 2.12 Power calculation

```
//chapter 2
//For Half wave Dipole
//Hphi=Im/(2*pi*r)*cos(pi/2*cos(theta)/sin(theta))
//Rrad=73 ohm
Hphi=5*10^-6;
r=2*10^3;
Im=(5*10^-6)*(4*(%pi)*10^3);
Prad=73*(Im/sqrt(2))^2;
printf("the radiated power is %gW",Prad);
```

Scilab code Exa 2.13 power calculation

```
//chapter 2
//For quarter wave monopole
//Rrad=36.5 ohm
Im=20*(%pi)*10^-3;//from previous problem
Prad=36.5*((20*(%pi)*10^-3)/sqrt(2))^2;
printf("the radiated power is %gW",Prad);
```

Scilab code Exa 2.14 Dipole length calculation

```
//chapter 2
//lamda=velocity/frequency
printf("\n");
frequency=50*10^6;
```

```
lamda=3*10^8/frequency;
leng=lamda/2;
printf("the length of the dipole antenna is %dm",
   leng);
```

Scilab code Exa 2.15 Current calculation

```
//chapter 2
//Etheta=60*Im*cos(pi/2*cos(theta)/sin(theta))/r
printf("\n");
r=500*10^3;
Etheta=10*10^-6;
Im=Etheta*r/60;
printf("the current through the dipole is %gA",Im);
```

Scilab code Exa 2.16 power calculation

```
//chapter 2
//for half wave dipole
Pavg=0.5*73*0.0833;//Rrad*Irms^2;Rrad=73 ohm
printf("the radiated power is %gW",Pavg);
```

Scilab code Exa 2.17 Directivity calculation

```
//chapter 2
//efficiency=Prad/Pinput
//efficiency=0.95,Umax=0.5W/sr,D=Umax/[Prad/4*pi];
//part (i)
printf("\n");
Pinput=0.4;
```

```
n=0.95;
Umax=0.5;
Prad=n*Pinput;
printf("the radiated power is %gW",Prad);
D=0.5/(0.38/(4*(%pi)));
printf("\nthe directivity is %g",D);
//part(ii)
Prad=0.3;
D=0.5/(0.3/(4*(%pi)));
printf("\nthe directivity is%g",D);
```

Scilab code Exa 2.18 efield calculation

```
//chapter 2
//for half wave dipole
//on applying kvl
printf("\n");
Im=0.0768;
Rrad=73;
r=10^4;
Prad=0.5*Rrad*Im^2;//Rrad=73 for half wave dipole
printf("the radiated power is %gW",Prad);
Gd=1.6405//on taking antilog of Gd(in db)
E4=Prad/(4*(%pi)*r^2);
E3=1.6405*E4;
E2=E3*240*(%pi);
printf("\n%g",E2);
E=sqrt(E2);
printf("\nthe field value is %gV/m",E);
```

Scilab code Exa 2.19 power calculation

```
//chapter 2
```

```
//frequency=100 MHz
printf("\n");
frequency=100*10^6;
lamda=3*10^8/frequency;
leng=lamda/2;
printf("the length of antenna is %gm",leng);
Rrad=73;
Im=25;
Prad=Rrad*0.5*Im^2;
printf("\nthe power radiated is %gW",Prad);
```

Scilab code Exa 2.20 Radiation resistance calculation

```
//chapter 2
printf("\n");
Im=15;
Prad=6*10^3;
Rrad=Prad/(Im/sqrt(2))^2;
printf("the radiation resistance is %gohm",Rrad);
```

Scilab code Exa 2.21 Directive gain calculation

```
//chapter 2
//Gpmax=n*Gdmax
//N=Rrad/Rrad+Rloss
printf("\n");
Rrad=72;
Rloss=8;
n=Rrad/(Rrad+Rloss);
printf("the radiation efficiency is given by %g",n);
Gpmax=15.8489;//antilog(Gpmax/10);Gpmax=12db
Gdmax=Gpmax/n;
Gdmaxdb=10*log10(Gdmax);
```

```
printf("\nthe directive gain is %g",Gdmax);
printf("\nthe directive gain in db is %g",Gdmaxdb);
```

Scilab code Exa 2.22 Radiation efficiency calculation

```
//chapter 2
printf("\n");
dl=1/40;
Im=125;
Rloss=1;
Rrad=80*(%pi)^2*(dl)^2;
printf("the Radiation resistance is %gohm",Rrad);
Irms=Im/sqrt(2);
Prad=Rrad*(Irms)^2;
printf("\nthe Power radiated is %gW",Prad);
n=Rrad/(Rrad+Rloss);
printf("\nthe radiation efficiency is %g",n);
```

Scilab code Exa 2.23 Efield calculation

```
//chapter 2
//|E|^2=sqrt(60*Gd*Prad)/r;
printf("\n");
r=10^4;
Gd=3.1622//antilog(5db/10)
Prad=20*10^3;
E=sqrt(60*Gd*Prad)/r;
printf("the Electric field value is %gV/m",E);
```

Scilab code Exa 2.24 Efield calculation

```
//chapter 2
//Gd=antilog(12db/10)
printf("\n");
Gd=15.85;
Prad=5*10^3;
r=3*10^3;
E=sqrt(60*Gd*Prad)/r;
printf("the electric field is %gV/m",E);
```

Scilab code Exa 2.25 Radiation efficiency calculation

```
//chapter 2
//R=l*sqrt(pi*F*Uo*Sigma)/Sigma*2*pi*r
printf("\n");
L=2;
r=1*10^-3;
f=2*10^6;
u=4*(%pi)*10^-7;
sig=5.7*10^6;
R=sqrt((%pi)*2*10^6*4*(%pi)*10^-7/(5.7*10^6))*L/(2*(
   %pi)*10^-3);
printf("the resistance of hertzian dipole is %gohm",
   R);
dl=2
frequency=2*10^6;
lamda=3*10^8/(frequency);
Rrad=80*(%pi)^2*(dl/lamda)^2;
n=Rrad/(Rrad+R);
printf("\nthe radiation efficiency is %gohm",n);
```

Scilab code Exa 2.26 Radiation efficiency calculation

```
//chapter 2
```

```
//half wave dipole
printf("\n");
dl=1/15;//assume lamda=1;
Rloss=1.5;
Rrad=80*(%pi)^2*(1/15)^2;
n=Rrad/(Rrad+Rloss);
printf("the radiation efficiency is %g",n);
```

Scilab code Exa 2.27 Voltage calculation

```
//chapter 2
//Leff=Voc/E
printf("\n");
Leff=8;
E=0.01;
Voc=Leff*E;
printf("the voltage induced is %gV",Voc);
```

Scilab code Exa 2.28 Dipole length calculation

```
//chapter 2
//Antenna Bandwidth=Operating Frequency/Q;
printf("\n");
Q=30;
f=10*10^6;
f0=f*Q;
c=3*10^8;
lamda=c/f0;
leng=lamda/2;
printf("the length of the half wave dipole is %gm",
    leng);
```

Scilab code Exa 2.29 effective aperture calculation

```
//chapter 2
//part a
printf("\n");
c=3*10^8;
f=10^9;
lamda=c/f;
printf("the wavelength is %gm",lamda);
//part b
dl=3*10^-2;
Rrad=80*(%pi)^2*(dl/lamda)^2;
printf("\nthe radiation resistance is %gohm",Rrad);
//part c
Gdmax=1.5//Gd=1.5sin^2(theta),where theta=90 for short dipole
n=0.6;
Gp=n*Gdmax;
printf("\nthe antenna gain is given by %g",Gp);
//part d
Ae=1.5*(lamda)^2/(4*(%pi));
printf("\nthe effective aperture is %gm^2",Ae);
```

Scilab code Exa 2.30 Noise power calculation

```
//chapter 2
//P=k(Ta+Tr)B
printf("\n");
Ta=15;
Tr=20;
b=4*10^6;
//part a
```

```
k=1.38*10^-23;
Pb=k*(Ta+Tr);
printf("the power per unit bandwidth is %gW/hz",Pb);
//part b
P=Pb*b;
printf("\nthe available noise power is %gW",P);
```

Scilab code Exa 2.31 Tuning factor calculation

```
//chapter 2
//Q=Fo/delf;
printf("\n");
f0=30*10^6;
f=600*10^3;
Q=f0/f;
printf("the tuning factor Q is %d",Q);
```

Scilab code Exa 2.32 Antenna gain calculation

```
//chapter 2
//part a
printf("\n");
c=3*10^8;
frequency=20*10^9;
lamda=c/frequency;
printf("the wavelength is %gm",lamda);
//part b
//Ae=G*(lamda)^2/4*pi
r=0.61;
Aep=(%pi)*r^2;
printf("\nthe effective physical aperture is %gm^2",
    Aep);
Ae=0.55*Aep;
```

```
Ga=(Ae*4*(%pi))/(lamda)^2;
Gdb=10*log10(Ga);
printf("\nthe antenna gain is %g",Ga);
printf("\nthe antenna gain in db is %gdb",Gdb);
```

Scilab code Exa 2.33 Dipole length calculation

```
//chapter 2
printf("\n");
f=30*10^6;
c=3*10^8;
lamda=c/f;
leng=lamda/2;
printf("the length of half wave dipole is %dm",leng)
    ;
```

Scilab code Exa 2.34 Directive gain calculation

```
//chapter 2
printf("\n");
Rrad=72;
Rloss=8;
Gp=16;
n=Rrad/(Rrad+Rloss);
printf("the radiation efficiency is %g",n);
Gp=16;
Gd=Gp/n;
Gddb=10*log10(Gd);
printf("\nthe directive gain is %g",Gd);
printf("\nthe directive gain in db is %gdb",Gddb);
```

Scilab code Exa 2.35 power calculation

```
//chapter 2
printf("\n");
Gt=1.5;
Gr=1.5;
d=10;
Pt=15;
f=10^9;
c=3*10^8;
lamda=c/f;
Pr=Pt*Gt*Gr*(lamda/(4*(%pi)*d))^2;
printf("the radiated power is %gW",Pr);
```

Scilab code Exa 2.36 power calculation

```
//chapter 2
printf("\n");
f=2*10^9;
c=3*10^8;
lamda=c/f;
printf("the wavelngth is %gm",lamda);
//part b
Pr=10^-12;
Gt=200;
Gr=200;
d=3*10^6;
Pt=((4*(%pi)*d)/lamda)^2*(Pr/(Gt*Gr));
printf("\nthe transmitted power is %gW",Pt);
```

Scilab code Exa 2.37 Gain calculation

```
//chapter 2
```

```
//part a
printf("\n");
c=3*10^8;
f=100*10^6;
lamda=c/f;
printf("the wavelength is %dm",lamda);
//part b
Gt=15.8489//antilog(12/10)
Pt=10^-1;
Pr=10^-9;
d=384.4*10^6;//238857*1609.35
Gr=(((4*(%pi)*d)/lamda)^2*Pr)/(Pt*Gt);
printf("\nthe gain of receiver is %g",Gr);
Grdb=10*log10(Gr);
printf("\nthe gain of receiver in db is %gdb",Grdb);
```

Scilab code Exa 2.38 Bandwidth calculation

```
//chapter 2
printf("\n");
Q=15;
lamda=1;
c=3*10^8;
f0=c/lamda;
Bw=f0/Q;
printf("the bandwidth of antenna is %eHz",Bw);
```

Scilab code Exa 2.39 Directive gain calculation

```
//chapter 2
//Aemax=Gdmax*lamda^2/4*pi;
printf("\n");
Aemax=0.13;//assume lamda=1 for half wave dipole
```

```
Gdmax=4*(%pi)*Aemax;
printf("the maximum directive gain is %g",Gdmax);
Gdmaxdb=10*log10(Gdmax);
printf("\nthe maximum directive gian in db is %gdb",
   Gdmaxdb);
```

Scilab code Exa 2.40 Radiated power calculation

```
//chapter 2
printf("\n");
Rloss=1;
Ra=73;
Im=14.166*10^-3;//on applying kvl
Prad=(Im/sqrt(2))^2*(Rloss+Ra);
printf("the radiated power is %gW",Prad);
```

Scilab code Exa 2.41 Average power calculation

```
//chapter 2
//Etheta=n0Im/2pir*cos(pi/2 cos(theta)/sin(theta))
printf("\n");
Pin=100;
n=0.5;
r=500;
Prad=n*Pin;
printf("the radiated power is %gW",Prad);
Rrad=73;//for half wave dipole
Im=sqrt((2*Prad)/Rrad);
n0=120*(%pi);
Etheta=(cos((%pi/2)*cos(%pi/3))/sin(%pi/3))*n0*(Im
   /(2*(%pi)*r));
printf("\nthe electric field is given by %gV/m",
   Etheta);
```

```
Pavg=(0.5*(Etheta)^2)/(n0);
printf("\nthe average power is %gW",Pavg);
```

Scilab code Exa 2.42 Radiation Power calculation

```
//chapter 2
//may june 2008
printf("\n");
Pt=15
Aet=2.5;
Aer=0.5;
d=15*10^3;
f=5*10^9;
c=3*10^8;
lamda=c/f;
Pr=(Pt*Aet*Aer)/((d)^2*(lamda)^2);
printf("the radiated power is %gW",Pr);
```

Scilab code Exa 2.43 Directive gain calculation

```
//chapter 2
//may june 2009
printf("\n");
n=10;
d=0.25;
lamda=1;//assume
Gdmax=4*((n*d)/lamda);
printf("\nthe maximum directive gain is %g",Gdmax);
Gdmaxdb=10*log10(Gdmax);
printf("\nthe maximum directive gain in db is %gdb",
   Gdmaxdb);
```

Scilab code Exa 2.44 Radiation efficiency calculation

```
//chapter 2
//nov-dec 2012
printf("\n");
Rrad=65;
Rloss=10;
n=Rrad/(Rrad+Rloss);
printf("the radiation efficiency is %g",n);
```

Scilab code Exa 2.45 Effective aperture calculation

```
//chapter 2
//may june 2013
//Aem=Gdmax*lamda^2/4*pi;
printf("\n");
Gdmax=1.5;//for half wave dipole
f=10^9;
c=3*10^8;
lamda=c/f;
Aem=(Gdmax*(lamda)^2)/(4*(%pi));
printf("the effective aperture is %gm^2",Aem);
```

Scilab code Exa 2.46 FBR ratio calculation

```
//chapter 2
printf("\n");
Pdes=3*10^3;
Popp=500;
```

```
FBR=Pdes/Popp;
printf("the front to back ratio is %d",FBR);
```

Scilab code Exa 2.47 Radiation resistance calculation

```
//chapter 2
printf("\n");
dl=1/50;
Rr=80*(%pi)^2*(dl)^2;
printf("the radiation resistance is %gohm",Rr);
```

Chapter 3

Loop and Helical Antenna

Scilab code Exa 3.1 Directive gain calculation

```
//chapter 3
//tan(alpha)=s/c;
//helical antenna Gdmax=15NSC^2/lamda^3
printf("\n");
c=1;
n=20;
lamda=1;
s=tan(0.2093)*1;//12*pi/180 radians
Gdmax=(15*n*s*(c)^2)/(lamda)^3;
printf("the directive gain is %g",Gdmax);
```

Scilab code Exa 3.2 HPBW calculation

```
//chapter 3
//helical antenna
//part a
printf("\n");
c=3*10^8;
```

```
f=3*10^9;
lamda=c/f;
printf("the wavelength is %gm",lamda);
//part b
n=20;
s=0.03;
c=0.1;
Gdmax=(15*20*0.3*(0.1)^2)/(0.1)^3;
printf("\nthe directive gain is %g",Gdmax);
//part c
HPBW=sqrt((0.1)^3/(20*0.03))*520;
printf("\nthe half power beamwidth is %gdegree",HPBW
   );
```

Scilab code Exa 3.3 Radiation resistance calculation

```
//chapter 3
//loop antenna
printf("\n");
r=10;
lamda=100;
A=(%pi)*r^2;
Rr=31200*(A/lamda^2)^2;
printf("the radiation resistance is %gohm",Rr);
```

Scilab code Exa 3.4 Radiation Resisitance calculation

```
//chapter 3
//loop antenna
printf("\n");
l=1;
b=1;
A=l*b;
```

```
lamda=100;
Rrad=31200*(A/lamda^2);
printf("the radiation resistance is %gohm",Rrad);
```

Chapter 4

Antenna Arrays

Scilab code Exa 4.1 HPBW calculation

```
//chaptr 4
//D=2(L/lamda)
//broadside array
printf("\n");
L=1;
Lamda=1;//assume
BWFN=2 *180/(%pi);//2/(L/lamda)
printf("the Beam Width First Null is %gdegree",BWFN)
    ;
HPBW=BWFN/2;
printf("\nthe half power beam width is %gdegree",
    HPBW);
```

Scilab code Exa 4.2 BWFN calculation

```
//chapter 4
//end fire array
//D=4(L/lamda)
```

```
//BWFN=2sqrt(2m/(L/lamda))
printf("\n");
lamda=1;
D=36;
L=D/4;
m=1;
BWFN=114.6*sqrt(2*m/L);
printf("The Beam Width First Null is %gdegree",BWFN)
    ;
```

Scilab code Exa 4.3 Maxima Minima calculation

```
//chapter 4
//2 element array
//part a
printf("\n");
max1=acos(0);
max2=acos(1);
max3=acos(-1);
printf("the positions of maxima are %g,%d,%g radians
    ",max1,max2,max3);
//part b
//minima
min1=acos(0.5);
min2=acos(0.5);
printf("\nthe positions of minima are %g,%g radians"
    ,min1,min2);
```

Scilab code Exa 4.4 Radiation Pattern calculation

```
//chapter 4
//2 element array
```

```
//introduces warning at scanf statement but output is displayed
printf("\n");
max1=acos(1);
printf("the only position of maximum radiation is %d radians",max1);
min1=acos(-1);
printf("\nthe position of minimum radiation pattern is %g radians",min1);
phi=180;//assume phi=180 degree;
Et=2*cos(((%pi/4)*cos(phi))-(%pi/4));
disp(Et);
printf("Hence as the radiation pattern suggest that antenna is unidirectional antenna");
```

Scilab code Exa 4.5 Null Calculation

```
//chapter 4
//broadside array
//part a
printf("\n");
n=8;
m1=1;
d=0.5;
lamda=1;
ph1=acos((m1*lamda)/(n*d));
m2=2;
ph2=acos((m2*lamda)/(n*d));
m3=3;
ph3=acos((m3*lamda)/(n*d));
printf("the direction of nulls are");
printf("\n%g %g %g radians",ph1,ph2,ph3);
```

Scilab code Exa 4.6 Lobe calculation

```
//chapter 4
//from previous problems values
//broadside array
printf("\n");
m1=1;
n=8;
d=0.5;
lamda=1;
ph1=acos(lamda*(2*m1+1)/(2*n*d));
m2=2;
ph2=acos(lamda*(2*m2+1)/(2*n*d));
m3=3;
ph3=acos(lamda*(2*m3+1)/(2*n*d));
printf("the minor lobes values are");
printf("\n%g %g %g",ph1,ph2,ph3);
```

Scilab code Exa 4.7 BWFN calculation

```
//chapter 4
//broadside array
printf("\n");
n=4;
lamda=0.1
d=0.5
i=0.25
Rrad=73;
//part a
Prad=n*(i^2*Rrad);
printf("the radiated power is %gW",Prad);
//part b
L=n*d;
printf("\nthe length is %dm",L);
BWFN=2*lamda/L;
```

```
HPBW=BWFN/2;
printf("\nthe Beam width first null is %g radians",
   BWFN);
printf("\nthe half power beam width is %g radians",
   HPBW);
```

Scilab code Exa 4.8 Dmin calculation

```
//chapter 2
//broadside array
printf("\n");
Gdmax=5.01108;//antilog[7/10]
n=10;
lamda=1;
d=Gdmax/(20*lamda);
printf("the minimum distance between array is %gm",d
   );
```

Scilab code Exa 4.9 Gain calculation

```
//chapter 4
//broadside array
printf("\n");
n=8;
d=0.25;
lamda=1;
//part a
Gdmax=(2*n*d)/lamda;
Gdmaxdb=10*log10(Gdmax);
printf("In Case of Broadside array")
printf("\nthe directive gain is %g",Gdmax);
printf("\nthe directive gain in db is %gdb",Gdmaxdb)
   ;
```

```
//part b
//end fire array
Gdmax1=(4*n*d)/lamda;
Gdmaxdb1=10*log10(Gdmax1);
printf("\nIn case of End fire array");
printf("\nthe directive gain is %g",Gdmax1);
printf("\nthe directive gain in db is %gdb",Gdmaxdb1
    );
```

Scilab code Exa 4.10 BWFN calculation

```
//chapter 4
//broadside array
printf("\n");
Gdmax=15;
L=Gdmax/2;
printf("the length is %gm",L);
//endfire array
L1=Gdmax/4;
printf("\nthe length is %gm",L1);
BWFN=114.6*sqrt(2/L1);
printf("\nthe BWFN is %g degree",BWFN);
```

Scilab code Exa 4.11 Directivity calculation

```
//chapter 4
//Hansen-Woodyard end fire array
printf("\n");
n=10;
d=0.25;
L=n*d;
D=1.789*4*L;
Ddb=10*log10(D);
```

```
printf("the directivity is %g",D);
printf("\nthe directivity in db is %gdb",Ddb);
```

Scilab code Exa 4.12 Effective Aperture calculation

```
//chapter 4
//end fire array
printf("\n");
n=16;
d=0.25;
L=(n-1)*d;
m=1;
//part a
HPBW=57.3*sqrt((2*m)/L);
printf("the HPBW is %g degree",HPBW);
//part b
D=4*L;
Ddb=10*log10(D);
printf("\nthe directivity is %d",D);
printf("\nthe directivity in db is %gdb",Ddb);
//part c
A=4*(%pi)/D;
printf("\nthe beam solid angle is %gsr",A);
//part d
lamda=1;
Ae=D*lamda^2/(4*(%pi));
printf("\nthe effective aperture is %gm^2",Ae);
```

Scilab code Exa 4.13 Directive Gain Calculation

```
//chapter 4
//end fire array
printf("\n");
```

```
n=10;
d=0.25;
lamda=1;//assume
Gdmax=4*n*d;
Gdmaxdb=10*log10(Gdmax);
printf("the directive gian is %d",Gdmax);
printf("\nthe directive gain in db is %ddb",Gdmaxdb)
    ;
```

Scilab code Exa 4.14 Directivity calculation

```
//chapter 4
//may june 2013
n=50;
d=0.5;
lamda=1;//assume
L=n*d;
D=2*(L/lamda);
printf("the directivity is %g",D);
```

Chapter 6

Aperture and Lens Antenna

Scilab code Exa 6.1 Directive gain calculation

```
//chapter 6
//horn antenna
printf("\n");
Ae=10;
del=0.2;
p=Ae^2/(8*del);
del1=0.375;
Thetae=2*atan((Ae/(2*p)))*180/(%pi);//flare angle
Thetah=2*acos(p/(p+del1))*180/(%pi);
Ah=2*p*tan(((Thetah*(%pi)/180)/2));
printf(" the length is %gm",p);
printf("\n the angle ThetaE is %g degree",Thetae);
printf("\n the angle ThetaH is %g degree",Thetah);
printf("\n the H plane aperture is %g",Ah);
HPBWH=67/Ah;
HPBWE=56/Ae;
Ddb=10*log10((7.5*Ae*Ah));
printf("\n the HPBWE is %g degree",HPBWE);
printf("\n the HPBWH is %g degree",HPBWH);
printf("\n the Directive gain in db is %gdb",Ddb);
```

Scilab code Exa 6.2 Effective aperture calculation

```
//chapter 6
//may june 2009
//parabolic reflector antenna
printf("\n");
BWFN=10;
f=3*10^9;
c=3*10^8;
lamda=c/f;
d=140*lamda/(BWFN);
printf("the diameter d is %gm",d);
//For circular parabolidal antenna
Ae=((%pi)*(d^2))/4;
printf("\nthe effective aperture is %gm^2",Ae);
```

Chapter 7

Propagation of Radio Waves

Scilab code Exa 7.1 frequency calculation

```
//chapter 7
printf("\n");
fcr=11*10^6;
D=1000;
h=400;
fmuf=fcr*sqrt(1+(D/(2*h))^2);
printf("the maximum stable frequency is %gHz",fmuf);
```

Scilab code Exa 7.2 Usable frequency calculation

```
//chapter 7
printf("\n");
Nmax=10^11;
phi=(%pi)/9;
fcr=sqrt(81*Nmax);
printf("the critical frequency is %gHz",fcr);
fmuf=fcr*sec(phi);
printf("\nthe maximum usable frequency is %gHz",fmuf
    );
```

Scilab code Exa 7.3 Critical frequency calculation

```
//chapter 7
printf("\n");
D=2000;
h=200;
fmuf=30.6*10^6;
fcr=fmuf/sqrt(1+(D/(2*h))^2);
printf("the critical frequency is %gHz",fcr);
```

Scilab code Exa 7.4 Skip distance calculation

```
//chapter 7
printf("\n");
n=0.9;
fmuf=10*10^6;
f=10*10^6;
h=400*10^3;
Nmax=(1-n^2)*f^2/81;
printf("the Nmax value is %g /m^3",Nmax);
fcr=sqrt(81*Nmax);
printf("\n the critical frequency is %gHz",fcr);
Dskip=2*h*sqrt((fmuf/fcr)^2-1);
printf("\n the skip distance is %gm",Dskip);
```

Scilab code Exa 7.5 Efield calculation

```
//chapter 7
printf("\n");
```

```
ht=150;
hr=2;
Is=9;
d=40*10^3;
f=1.2*10^6;
c=3*10^8;
lamda=c/f;
printf("the wavelength is %dm",lamda);
E=120*(%pi)*ht*hr*Is/(lamda*d);
printf("\nthe electric field is %gV/m",E);
```

Scilab code Exa 7.6 Transmission height calculation

```
//chapter 7
printf("\n");
dmax=45*10^3;
ht=(dmax/8.24)^2;//dmax=4.12[sqrt(ht)+sqrt(hr)];ht=
    hr;
printf("the height of transmission is %gm",ht);
```

Scilab code Exa 7.7 Nmax calculation

```
//chapter 7
printf("\n");
fcre=2.5*10^6;
fcrf=8.5*10^6;
Nmaxe=(fcre)^2/81;
Nmaxf=(fcrf)^2/81;
printf("the Nmax for e layer is %g /m^3",Nmaxe);
printf("\n the Nmax for f layer is %g /m^3",Nmaxf);
```

Scilab code Exa 7.8 Critical freq calculation

```
//chapter7
printf("\n");
Nmaxf1=2.5;
Nmaxf2=3.5;
Nmaxf3=1.5;//10^6*10^-6=1;
fcr1=sqrt(81*Nmaxf1);
fcr2=sqrt(81*Nmaxf2);
fcr3=sqrt(81*Nmaxf3);
printf("the critical frequencies are");
printf("\n %gHz %gHz %gHz",fcr1,fcr2,fcr3);
```

Scilab code Exa 7.9 Electron Density calculation

```
//chapter7
printf("\n");
fcr1=4.5*10^6;
fcr2=1.5*10^6;
Nmax1=(fcr1/9)^2';
Nmax2=(fcr2/9)^2;
printf("the Nmax values are");
printf("\n %gm^3 %gm^3",Nmax1,Nmax2);
Nmax=Nmax1-Nmax2;
printf("\n the change in electron density is %gm^3",
   Nmax);
```

Scilab code Exa 7.10 Frequency calculation

```
//chapter 7
//the power is 10^6 and not 10^-6 as in book
printf("\n");
n=0.5;
```

```
N=400*10^6;
f=sqrt((81*N)/(1-n^2));
printf("the frequency is %eHz",f);
```

Scilab code Exa 7.11 Critical freq calculation

```
//chapter 7
printf("\n");
D=1500;
h=250;
fmuf=37.95*10^6;
fcr=fmuf/sqrt(1+(D/(2*h))^2);
printf("the critical frequency is %eHz",fcr);
```

Scilab code Exa 7.12 Usable freq calculation

```
//chapter 7
printf("\n");
D=2500;
h=200;
fcr=5*10^6;
fmuf=fcr*sqrt(1+(D/(2*h))^2);
printf("the maximum usable frequency is %gHz",fmuf);
```

Scilab code Exa 7.13 virtual height calculation

```
//chapter 7
printf("\n");
T=5*10^-3;
c=3*10^8;
```

```
h=c*(T/2);
printf("the virtual height is given by %gm",h);
```

Scilab code Exa 7.14 LOS calculation

```
//chapter 7
printf("\n");
ht=40;
hr=25;
f=90*10^6;
p=35;
LOS=4.12*(sqrt(ht)+sqrt(hr));
printf("the line of sight distance is %gm",LOS);
```

Scilab code Exa 7.15 critical freq calculation

```
//chapter 7
printf("\n");
Nmax=1.26*10^12;
fcr=sqrt(81*Nmax);
printf("the critical frequency is %gHz",fcr);
```

Scilab code Exa 7.16 critical freq calculation

```
//chapter 7
//may june 2008
printf("\n");
Nmax=1.24*10^12;
fcr=sqrt(81*Nmax);
printf("the critical frequency is %gHz",fcr);
```

Scilab code Exa 7.17 usable freq calculation

```
//chapter 7
printf("\n");
fcr=6*10^6;
D=200*10^3;
h=200*10^3;
fmuf=fcr*sqrt(1+(D/(2*h))^2);
printf("the maximum usable frequency is %gHz",fmuf);
```

Scilab code Exa 7.18 Range calculation

```
//chapter 7
printf("\n");
ht=100;
hr=50;
d=1.4142*(sqrt(ht)+sqrt(hr));
printf("the maximum range is %gmiles",d);
```