

Scilab Manual for
Satellite Communication
by Dr Lochan Jolly
Electrical Engineering
Thakur College of Engineering & Technology¹

Solutions provided by
Dr Lochan Jolly
Electrical Engineering
Mumbai university/ Thakur college of engg and tech

April 4, 2026

¹Funded 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 Scilab Solutions	3
1 To calculate coverage angle.	5
2 To calculate slant range .	7
3 To calculate propagation delay	9
4 To calculate Antenna Look Angels.	11
5 To calculate Limits of visibility.	14
6 To calculate Antenna Power and antenna gain for any given satellite communication antenna.	17
7 To calculate EIPR for any given satelite communication link.	19
8 To calculate (C/N) for Communication Satellite link considering various losses when input transmitted power is given.	21
9 To calculate (C/N) for Communication Satellite link considering various losses when saturation flux density is given.	24
10 To calculate total C/N after calculating (C/N)Downlink and (C/N)uplink.	27
11 To calculate total noise temperature for any given satellite communication link.	29

List of Experiments

Solution 1.1	Coverage angle	5
Solution 2.2	slant range	7
Solution 3.3	Propagation Delay	9
Solution 4.4	Look angels	11
Solution 5.5	Visibility Limit	14
Solution 6.6	Antenna	17
Solution 7.7	Link1	19
Solution 8.8	Link2	21
Solution 9.9	Link3	24
Solution 10.10	Total SNR	27
Solution 11.11	Noise Temperature	29

List of Figures

1.1 Coverage angle	6
2.1 slant range	8
3.1 Propagation Delay	10
4.1 Look angels	13
5.1 Visibility Limit	16
5.2 Visibility Limit	16
6.1 Antenna	18
7.1 Link1	20
8.1 Link2	23
9.1 Link3	26
10.1 Total SNR	28
11.1 Noise Temperature	31

Experiment: 1

To calculate coverage angle.

Scilab code Solution 1.1 Coverage angle

```
1 //find coverage angle for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 clc;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14
15 alpha=reh/rsh;
16 ca=2*asind(alpha*cosd(E));
17 disp ("degree", ca,"coverage angle=");
```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

coverage angle=

    17.333991

degree

-->exec('Z:\be extc b\Naastcom practicals\EXP1.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

coverage angle=

    17.134298

degree

-->exec('Z:\be extc b\Naastcom practicals\EXP1.sce', -1)
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

coverage angle=

    16.803379

degree

-->
```

Figure 1.1: Coverage angle

Experiment: 2

To calculate slant range .

Scilab code Solution 2.2 slant range

```
1 //find slant range for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 //clc;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14 //rsh=42164;
15 //reh=6378;
16 //E=5;
17 v=3*10^8;
18 alpha=reh/rsh;
19 S=cosd(E+alpha)*reh/sind(alpha);
20 disp ("Km",S, " Slant Range=");
```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

Slant Range=
2406064.9

End

-->exec('Z:\be extc b\Nsaatcom practicals\EXP2.sce', -1)
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

Slant Range=
2378004.5

End

-->exec('Z:\be extc b\Nsaatcom practicals\EXP2.sce', -1)
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

Slant Range=
2331846.

End

-->
```

Figure 2.1: slant range

Experiment: 3

To calculate propagation delay

Scilab code Solution 3.3 Propagation Delay

```
1 //find propagation delay for given elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;
8 clear;
9 close;
10 //clc;
11 rsh=input("enter the height of satellite rsh");
12 reh=input("enter the radius of earth reh");
13 E=input("enter the value of angle of Elevation");
14 //rsh=42164;
15 //reh=6378;
16 //E=5;
17 v=3*10^8;
18 alpha=reh/rsh;
19 S=cosd(E+alpha)*reh/sind(alpha);
20 P=2*S/v;
21 disp ("sec",P, " Propagation delay=");
```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation5

Propagation delay=

0.0160404

sec

-->exec('Z:\be extc b\Naastcom practicals\EXP3.sce', -1)
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation10

Propagation delay=

0.0158534

sec

-->exec('Z:\be extc b\Naastcom practicals\EXP3.sce', -1)
enter the height of satellite rah42164
enter the radius of earth reh6378
enter the value of angle of Elevation15

Propagation delay=

0.0155456

sec

-->|
```

Figure 3.1: Propagation Delay

Experiment: 4

To calculate Antenna Look Angels.

Scilab code Solution 4.4 Look angels

```
1 //find Azimuth and elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //La=39;
6 //dirae='N';
7 //Loe=77;
8 //diroe='W'
9 //Los=99;
10 //diros='W';
11 //re=6318;
12 //rs=42164;
13 clear;
14 close;
15 clc;
16 La=input("enter the value of Latitude of ES Lae");
17 dirae=input("enter the direction of Lattitude s (N/S
    )");
18 Loe=input("enter the value of Longitude of earth
```

```

        station Loe");
19 diroe=input("enter the direction of Longitude of ES
    (E/W)");
20 Los=input("enter the value of Longitude of satellite
    Los");
21 diros=input("enter the direction of Longitude of
    Satellite (E/W)");
22 re=input("enter the value of earth radius re");
23 rs=input("enter the height of satellite rs");
24 Adash=atand(tand(Los-Loe)/sind(La));
25 El=atand((rs-re*cosd(La)*cosd(abs(Los-Loe)))/(re*
    sind(acosd(cosd(La)*cosd(abs(Los-Loe)))))-acosd(
    cosd(La)*cosd(abs(Los-Loe)))
26
27 if dirae=='N' then
28     if diroe=='E' & diros=='E' then
29         if Loe>Los then A=180+Adash; else A=180-Adash;
30         end; end;
31     if diroe=='E' & diros=='W' then A=180+Adash; end;
32     if diroe=='W' & diros=='E' then A=180-Adash; end
33     ;
34     if diroe=='W' & diros=='W' then
35         if Loe>Los then A=180-Adash; else A=180+Adash;
36         end; end;
37 end;
38 if dirae=='S' then
39     if diroe=='E' & diros=='E' then
40         if Loe>Los then A=360-Adash; else A=Adash; end;
41         end;
42     if diroe=='E' & diros=='W' then A=360-Adash; end
43     ;
44     if diroe=='W' & diros=='E' then A=Adash; end;
45     if diroe=='W' & diros=='W' then
46         if Loe>Los then A=Adash; else A=360-Adash;
47         end; end;
48 end;
49 disp ("degree", A, "Azimuth=");
50 disp ("degree", El, "Angle of elevation=");

```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the value of Latitude of ES Loe39
enter the direction of Latitude s (N/S)'M'
enter the value of Longitude of earth station Loe77
enter the direction of Longitude of ES (E/W)'M'
enter the value of Longitude of satellite Loe99
enter the direction of Longitude of Satellite (E/W)'M'
enter the value of earth radius re6378
enter the height of satellite rs42164

Azimuth=

    212.70063

degree

angle of elevation=

    39.386637

degree

-->
```

Figure 4.1: Look angels

Experiment: 5

To calculate Limits of visibility.

Scilab code Solution 5.5 Visibility Limit

```
1 //find limit of visibility of Earth station at
   certain lattitude and longitude and with certain
   elevation
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //rsh=42164;
6 //reh=6378;
7 //E=5;u can also keeo E=0,10
8 //La=48.429
9 //Lo=89.23
10 // dir='W'
11 clear;
12 close;
13 clc;
14 rsh=input("enter the height of satellite rsh");
15 reh=input("enter the radius of earth reh");
16 E=input("enter the value of angle of Elevation");
17 La=input("enter the value of Latitude La");
18 Lo=input("enter the value of Longitude Lo");
19 dir1=input("enter the direction of Longitude s (E/W)
```

```

    ");
20 x=rsh*cosd(E)/rsh;
21 alpha=asind(x);
22 theta=90-E-alpha;
23 beta1=acosd(cosd(theta)/cosd(La));
24 LV1=Lo+beta1;//limit of visibility
25 LV2=Lo-beta1;//limit of visibility
26 if LV1>0 s1=dir1
27 elseif (dir1=='E') s1='W'
28 elseif (dir1=='W') s1='E'
29 end
30 if LV2>0 s2=dir1
31 elseif (dir1=='E') s2='W'
32 elseif (dir1=='W') s2='E'
33 end
34 disp ("degree", s1, abs(LV1),"Limit of visibilty 1="
    );
35 disp ("degree", s2, abs(LV2),"Limit of visibilty 2="
    );

```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation0
enter the value of Latitude La48.429
enter the value of Longitude Lo89.23
enter the direction of Longitude s (E/W)'W'

Limit of visibility 1=
    166.05263
W
degree
Limit of visibility 2=
    12.407367
W
degree

Limit of visibility 1=
```

Figure 5.1: Visibility Limit

```
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the height of satellite rsh42164
enter the radius of earth reh6378
enter the value of angle of Elevation5
enter the value of Latitude La48.429
enter the value of Longitude Lo89.23
enter the direction of Longitude s (E/W)'W'

Limit of visibility 1=
    158.37017
W
degree
Limit of visibility 2=
    20.089826
```

Figure 5.2: Visibility Limit

Experiment: 6

To calculate Antenna Power and antenna gain for any given satellite communication antenna.

Scilab code Solution 6.6 Antenna

```
1 //find the gain of an antenna
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=4
6 //Pt=100
7 //Dt=3
8 clear;
9 close;
10 clc;
11 F=input("enter the value of frequency in Ghz F")
12 c=3e8;
13 lambda= c/(F*1e9);
14 //find the gain of parabolic reflector at given
    frequency and daimeter
```



Figure 6.1: Antenna

```

15 eta=0.55; // efficiency
16 Pt=input("Power at the input of the antenna")
17 Dt=input("enter the value of daimeter of
           transmitting antenna=");
18 Gt=eta*(%pi*Dt/lambda)^2;
19 Gtdb=10*log(Gt);
20 po=Gt*Pt;
21 disp (Gtdb,"Antenna gain in dB=");
22 disp ('Watts',po,"Power output from the antenna=");

```

Experiment: 7

To calculate EIPR for any given satellite communication link.

Scilab code Solution 7.7 Link1

```
1 //Find EIRP
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=4
6 //Pt=100
7 //Dt=3
8 clear;
9 close;
10 clc;
11 F=input("enter the value of frequency in Ghz F")
12 c=3e8;
13 lambda= c/(F*1e9);
14 eta=0.55;//efficiency
15 Pt=input("Power at the input of the antenna")
16 Dt=input("enter the value of daimeter of
    transmitting antenna=");
17 Gt=eta*(%pi*Dt/lambda)^2;
18 Gtdb=10*log(Gt);
```



Figure 7.1: Link1

```
19 po=Gt*Pt;  
20 EIRP=10*log(po);  
21 disp (Gtdb," Antenna gain in dB=");  
22 disp ('dB',EIRP," EIRP=");
```

Experiment: 8

To calculate (C/N) for
Communication Satellite link
considering various losses when
input transmitted power is
given.

Scilab code Solution 8.8 Link2

```
1 // To find the signal to noise ratio for satellite
   communication link for given input power
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //F=6.1
6 //Gtdb=54
7 //R=37500
8 //Losses=6
9 //Pt=100
10 //Grdb=26
11 //Ta=35
12 //Tr=500
```

```

13 //B=36
14 clear;
15 close;
16 clc;
17 F=input("enter the value of frequency in Ghz F");
18 c=3e8;
19 lambda= c/(F*1e9);
20 //find the gain of parabolic reflector at given
    frequency and diameter
21 Gtdb=input("enter the value of gain of transmitting
    antenna in dB=");
22 Gt=10^(Gtdb/10);
23 //calculate Free space Loss for given frequency and
    distance between earth and satellite log10
24 R=input("enter the value of distance between earth
    and satellite=");
25 FSL=(4*%pi*R*1e3/lambda);
26 FSLdb=20*log10(FSL);
27 losses=input("enter the value of additional losses
    in dB");
28 Totallosses=FSLdb+losses
29 TL=10^(Totallosses/10);
30 //determine received power
31 Pt=input("enter the value of power transmitted in W="
    ");
32 Grdb=input("enter the value receiver antenna gain in
    dB=");
33 Gr=10^(Grdb/10);
34 Pr=Pt*Gt*Gr/TL;
35 Prdb=10*log10(Pr);
36 //Calculate noise power density and noise power
37 Ta=input("enter the value of antenna noise
    temperature in K=");
38 Tr=input("enter the value receiver noise temperature
    in K=");
39 B=input("enter the value receiver bandwidth MHz=");
40 En=Ta+Tr;//equivalent noise temperature
41 K=1.36e-23;//Boltzman constant

```

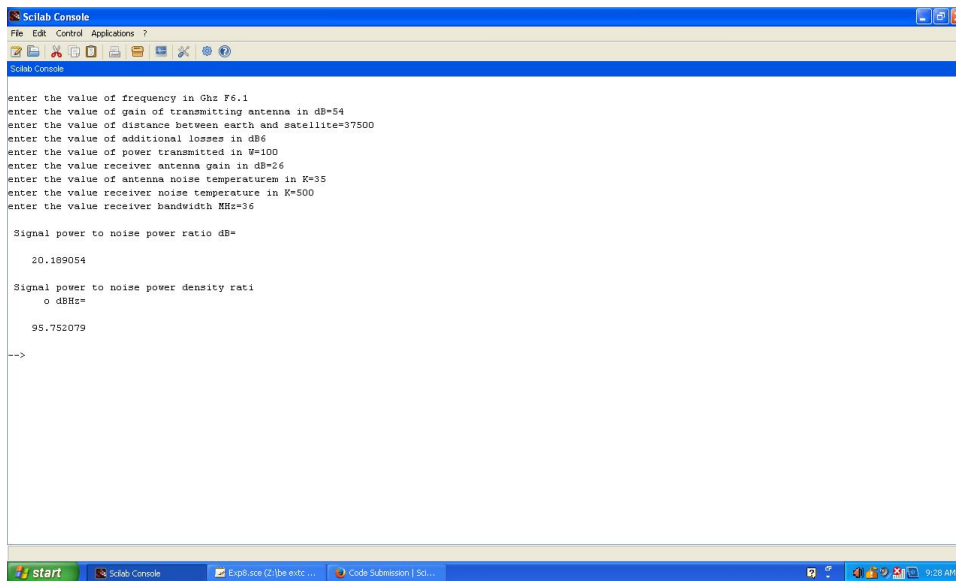


Figure 8.1: Link2

```

42 Pno=K*En*B*1e6; //noise power
43 Pnodb=10*log10(Pno);
44 Pnod=K*En; //noise power density
45 Pnoddb=10*log10(Pnod);
46 // signal to noise ratio
47 CN=Prdb-Pnodb;
48 CN0=Prdb-Pnoddb;
49 disp ('dB',CN,"Signal power to noise power ratio dB="
        " ");
50 disp ('dBHz',CN0,"Signal power to noise power
        density ratio dBHz=");

```

Experiment: 9

To calculate (C/N) for
Communication Satellite link
considering various losses when
saturation flux density is given.

Scilab code Solution 9.9 Link3

```
1 //uplink frequency is given and flux density  
   required to saturate the transponder is given  
   calculate signal to noise ratio  
2 //OS=Windows XP sp3  
3 //Scilab version 5.4.0  
4 //Sample Values  
5 //F=14  
6 //R=42164  
7 //saidb=-91.4  
8 //Bo=11  
9 //Pt=100  
10 //GT=-6.7  
11 clear;  
12 close;  
13 clc;
```

```

14 F=input("enter the value of frequency in Ghz F");
15 c=3e8;
16 K=-228.6;//dB Boltzman constant
17 lambda= c/(F*1e9);
18 R=input("enter the value of distance between earth
    and satellite=");
19 FSL=(4*%pi*R*1e3/lambda);//free space losses
20 FSLdb=20*log10(FSL);
21 saidb=input("enter the value of saturation flux
    density of transponder in dB=");
22 A0db=-10*log10(4*%pi/(lambda^2));
23 EIRPdb=saidb+FSLdb+A0db;
24 //disp (EIRPdb,"earth station EIRP required for
    saturation of transponder dB=");
25 Bo=input("enter the value of backoff=");
26 GT=input("enter the value of G/T in dB/K");
27 //B=input("enter the value of bandwidth in Hz");
28 //Bdb=10*log10(B);
29 CNUdb=EIRPdb+GT-Bo-K-FSLdb//Bdb;
30 disp ('dB',CNUdb,"Sinal to noise density ratio
    uplink=");

```

```
Scilab Console
File Edit Control Applications ?
Scilab Console
enter the value of frequency in Ghr F14
enter the value of distance between earth and satellite=42164
enter the value of saturation flux density of transponder in dB=-91.4
enter the value of backoff=11
enter the value of G/T in dB/K=-6.7

Signal to noise density ratio uplink=

    75.127766
-->
```

Figure 9.1: Link3

Experiment: 10

To calculate total C/N after calculating (C/N)Downlink and (C/N)uplink.

Scilab code Solution 10.10 Total SNR

```
1 //For given signal to noise ratio of uplink and down
  link calculate total signal to noise ratio of
  satellite link
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //CNUdb=26
6 //CNDdb=24
7 clear;
8 close;
9 clc;
10 //for given data of downlink calculate CND and CNT
11 CNUdb=input("enter the value of uplink signal to
  noise density ratio in dB=");
12 CNDdb=input("enter the value ofdownlink signal to
  noise density ratio in dB=");
13 //CNIdb=input("enter the value of inteference signal
```

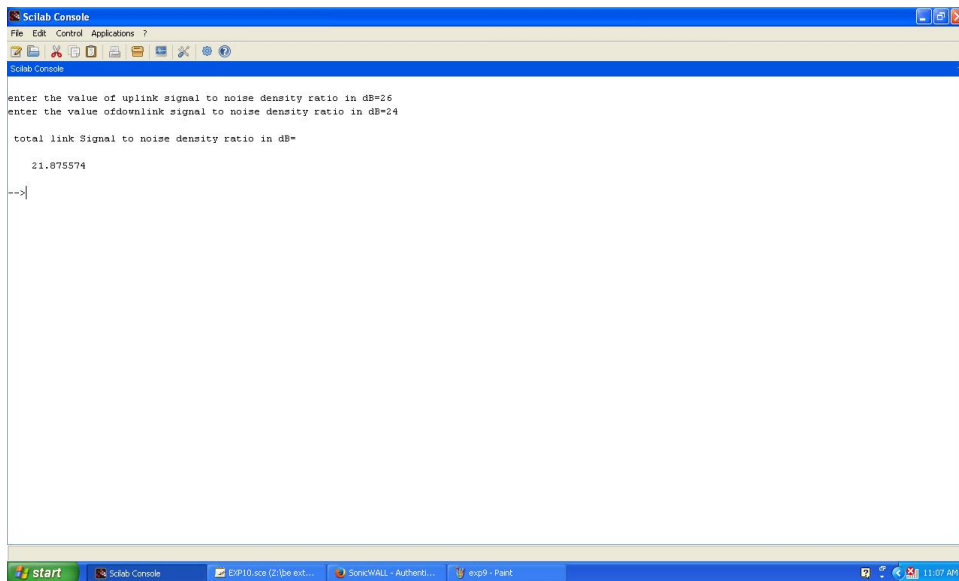


Figure 10.1: Total SNR

```
    to noise density ratio in dB=");
14  CND=10^(CNDdb/10);
15  CNU=10^(CNUdb/10);
16  //CNI=10^(CNIdb/10);
17  CNT=1/((1/CND)+(1/CNU)) // can add this term if
    interfernece is there (1/CNI));
18  CNTdb=10*log10(CNT);
19  disp (CNTdb,"total link Signal to noise density
    ratio in dB=");
```

Experiment: 11

To calculate total noise temperature for any given satellite communication link.

Scilab code Solution 11.11 Noise Temperature

```
1 //find equivalent noise temperature of N stage
  receiver here for lowest equivalent noise
  temperature we r assuming first stage is LNA and
  second stage is waverguide and subsequent stage
  are amplifiers for which noise figure and gain r
  specified
2 //OS=Windows XP sp3
3 //Scilab version 5.4.0
4 //Sample Values
5 //N=3
6 //Tant=35
7 //Te1=150
8 //G(1)=50
9 //L=5
10 //F(3)=12
11 //G(3)=5
12 clear;
```

```

13 close;
14 clc;
15 N=input("enter the No.of stages");
16 Tant=input("enter the antenna temperature");
17 Te1=input("enter the equivalent noise temperature of
    LNA");
18 G(1)=input("enter the gain of LNA in dB");
19 Ga(1)=10^(G(1)/10);
20 L=input("enter the attenuation of waveguide in dB");
21 La=10^(L/10);
22 To=290;
23 Te(2)=Tant+Te1+To*(L-1)/G(1)//gain till second stage
24 Ga(2)=Ga(1)/La;
25 for i=3:1:N//starting from 3rd stage to N stage
26 F(i)=input("enter the noise figure of next stage in
    dB");
27 Fa(i)=10^(F(i)/10)
28 G(i)=input("enter the gain of next stage amplifier in
    dB ");
29 Ga(i)=10^(G(i)/10)
30 Te(i)=Te(i-1)+To*(Fa(i)-1)/(Ga(i-1)*Ga(i));
31 end
32 X=Te(i);
33 disp('K',X,"Equivalent noise temperature");

```



Figure 11.1: Noise Temperature