

Scilab Textbook Companion for
Satellite Communications
by D. C. Agarwal¹

Created by
Nizamuddin
b.tech

Electronics Engineering
Uttarakhand Technical University

College Teacher
Vaseem Ahmad
Cross-Checked by
Ganesh R

May 23, 2016

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website <http://scilab.in>

Book Description

Title: Satellite Communications

Author: D. C. Agarwal

Publisher: Khanna Publishers, New Delhi

Edition: 6

Year: 2006

ISBN: 81-7409-213-7

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.

Contents

List of Scilab Codes	4
29 Solved Problems	5

List of Scilab Codes

Exa 29.1	Calculate the radius of geostationary satellite	5
Exa 29.2	The space shuttle a LEO satellite often orbits at an altitude of 250km What happens if the altitude of the shuttle becomes less than 250km	5
Exa 29.3	Determine the linear velocity of the shuttle along its orbit	6
Exa 29.4	A satellite is rotating in an elliptical orbit Calculate its orbital period	6
Exa 29.5	Calculate the radius of the orbit	7
Exa 29.6	Estimate the rate of drift around the equator of the sub satellite in degree per day Is the satellite moving towards east or west	7
Exa 29.7	Calculate the velocity of the satellite in orbit	8
Exa 29.8	calculate the component of velocity towards an observer at an earth station	8
Exa 29.9	Determine the doppler shift of the received signal at the earth station Discuss the impact of this shift on signal bandwidth	8
Exa 29.10	calculate the dimension of a reflector antenna	9
Exa 29.11	Determine the receive power	9
Exa 29.12	Calculate the received power at earth station	10
Exa 29.13	Find the downlink noise power budget	10
Exa 29.14	Find CN ratio in the receiver in clear air	11
Exa 29.15	Find the earth station GT ratio	11
Exa 29.16	Calculate the new GT ratio	11
Exa 29.17	Bandwidth of satellite transponder is 36MHz Earth station use RRC filter Calculate the max bit rate	12
Exa 29.18	calculate the max bit rate that can be sent through this transponder with QPSK	12

Exa 29.19	Find the value of overall CN at the earth station	13
Exa 29.20	Calculate the power output of an uplink transmitter .	13
Exa 29.21	find output power rating required for the transmitter .	14
Exa 29.22	Calculate the uplink transmitter power required	14
Exa 29.23	Calculate the symbol rate	15
Exa 29.24	Estimate the BW occupied by the RF signal and the frequency range of transmitted signal	15
Exa 29.25	Calculate the required carrier to noise ratio	16
Exa 29.26	Calculate the earth station transmitter power needed for transmission of a baseband signal	16
Exa 29.27	Calculate the uplink power increase required for TDMA operation	17
Exa 29.28	Calculate the EIRP of a satellite downlink	17
Exa 29.29	Calculate the gain of 3 m paraboloidal antenna	17
Exa 29.30	Calculate the overall noise temperature of the system .	18
Exa 29.31	Calculate the carrier to noise spectral density ratio . .	18
Exa 29.32	Calculate the earth station EIRP required for saturation assuming clear sky conditions	19
Exa 29.33	Calculate the effective isotropic radiated power in watts as seen by the antenna	19
Exa 29.34	Calculate the noise power for a BW of 36 MHz	20
Exa 29.35	Calculate the total link loss	20
Exa 29.36	Calculate the clear sky carrier to noise ratio for a satel- lite TV system having worst case EIRP of 51 dbw . .	21
Exa 29.37	Calculate the transmission bit rate for stop and wait system	21
Exa 29.38	what should be the capacity of the transmit buffer . .	22
Exa 29.39	Calculate the transmission bit rate for Selective Repeat ARQ system	22
Exa 29.40	Calculate the noise power in transponder1 or in the in- bound SCPC FDMA channels	23
Exa 29.41	Calculate the noise power in the hub station receiver or in inbound SCPC FDMA channel	23
Exa 29.42	Calculate the noise power in transponder2	24
Exa 29.43	Calculate the noise power in the VSAT receivers	24
Exa 29.44	Calculate the power received at the satellite transmitted from the VSAT uplink	24
Exa 29.45	Calculate the uplink inbound CN ratio in transponder1	25

Exa 29.46	Calculate the max number of VSAT channels that can be handled by the system	25
Exa 29.47	Calculate the centrifugal force for a satellite of mass 100 kg orbiting with a velocity of 8 km per s at a height of 200 km	26
Exa 29.48	Determine the orbital velocity of a satellite moving in a circular orbit at a height of 150 km	26
Exa 29.49	Determine the semi major axis of elliptical orbit	27
Exa 29.50	Determine the orbital eccentricity	27
Exa 29.51	Determine the apogee the perigee and eccentricity	28
Exa 29.52	Determine the apogee and perigee distance	28
Exa 29.53	Determine the relationship between their orbital periods	28
Exa 29.54	Determine the escape velocity for an object to be launched from surface of earth	29
Exa 29.55	Calculate the period of a satellite in an eccentric elliptical orbit	29
Exa 29.56	Determine the orbital time period and the velocity at the apogee and perigee point	30
Exa 29.57	Determine the target eccentricity	31
Exa 29.58	Determine the apogee the perigee and eccentricity	31
Exa 29.59	Determine the orbital period	32
Exa 29.60	What will be the time taken by the satellite to move from A to B in the direction shown in figure	32
Exa 29.61	Determine the semi major axis and semi minor axis and the orbit eccentricity	33
Exa 29.62	Determine the orbital period of satellite2	33
Exa 29.63	Calculate the max deviation in latitude and also determine the max displacement in kms	34
Exa 29.64	Determine the magnitude of velocity impulse needed to correct the inclination of 2 degree	34
Exa 29.65	Determine the angle of inclination between the new orbital plane and the equatorial	35
Exa 29.66	Determine the theoretical max coverage angle also determine the max slant range	35
Exa 29.67	What would be the new max coverage angle and the slant range	36
Exa 29.68	Calculate the angle subtended by the arc of the satellite footprint at the center of the earth	36

Exa 29.69	Determine the round trip delay for an earth station . . .	37
Exa 29.70	Determine the max shadow angle that occurs at equinoxes for a satellite orbiting in a circular equatorial orbit at a height of 13622 km above the surface of earth also determine the max daily eclipse duration	38
Exa 29.71	Determine the total time from the first day of eclipse to the last day also determine the same for geostationary orbit at a height of 35786 km	38
Exa 29.72	Calculate the incremental velocity to be given to the satellite at the apogee point by the apogee kick motor to circularize the orbit	39
Exa 29.73	Determine the velocity change required to circularize the orbit	40
Exa 29.74	Determine the max line of sight distance between two communication satellites	40
Exa 29.75	Determine the max line of sight distance and also for geostationary satellites	41
Exa 29.76	Find the round trip propagation delay	41
Exa 29.77	Determine the round trip propagation delay	42
Exa 29.78	Determine the earth station azimuth and elevation angles	42
Exa 29.79	Determine the max eclipse time in a day during the full eclipse period	43
Exa 29.80	Determine the incremental velocity required to correct the orbit inclination	43
Exa 29.81	Determine the earth station azimuth and elevation angles	44
Exa 29.82	Calculate the power gain of a paraboloid reflector antenna with a mouth dia of 10 m at 6 GHz	45
Exa 29.83	Determine the width in degree in the elevation direction	46
Exa 29.84	Determine the antenna power gain in db and also the operational frequency	46
Exa 29.85	Determine the antenna power gain	47
Exa 29.86	Determine the earth station EIRP	47
Exa 29.87	Determine the equivalent noise temp of the cascaded arrangement	48
Exa 29.88	Determine the noise figure of the cascaded arrangement	48
Exa 29.89	Determine the earth station system noise temp and GT ratio referred to the input of the low noise amplifier	49

Exa 29.90	Determine the earth station system noise temp and GT ratio referred to the input of waveguide and input of down converter	49
Exa 29.91	Determine the first local oscillator frequency range of second oscillator frequency and frequency spectrum . .	50
Exa 29.92	Determine the first local oscillator frequency and range of second oscillator frequency and frequency spectrum and BW of BPF1 and BPF2	51
Exa 29.93	Determine the first local oscillator frequency range of second oscillator frequency and frequency spectrum . .	52
Exa 29.94	Determine the center frequency BW of BPF1 and range of second oscillator frequency	53
Exa 29.95	Find the system noise temperature and GT as referred to the input of low noise amplifier	53
Exa 29.96	Determine the equivalent noise temperature of the low noise amplifier	54
Exa 29.97	Determine the output powers of the three carriers . . .	55
Exa 29.98	Determine the power loss suffered by each one of the five carriers after all have combined and appeared at the output	55
Exa 29.99	Find the link carrier to noise ratio	56
Exa 29.100	determine C _{Nu} and C _{Nd} and C _N	57
Exa 29.101	Determine the carrier EIRP required to saturate the satellite TWTA	57
Exa 29.102	Determine the satellite EIRP for the retransmitted carrier	58
Exa 29.103	Determine the angular separation of the two satellites as viewed by the earth station also determine the separation distance between the two satellites in the orbit	58
Exa 29.104	Determine the angular separation and separation distance	59
Exa 29.105	Calculate the power flux density at the satellite for an earth station located at 90 degree W longitude and 40 degree N latitude	60
Exa 29.106	Determine the theoretical max area of the earth surface	61
Exa 29.107	Determine the percentage of the earth area covered for the two cases of angle of elevation	61

Exa 29.108 Determine the gain of spot beam antenna if the global
coverage antenna has a gain of 50 db 62

Chapter 29

Solved Problems

Scilab code Exa 29.1 Calculate the radius of geostationary satellite

```
1 //Ex:1
2 clc;
3 clear;
4 close;
5 u=3.986*10^5; //kepler's const in km^3sec^(-2)
6 T_P=86164.09; // time period of earth in sec
7 a=(T_P^2*(u/(4*pi*pi)))^(1/3);
8 printf("Radius of geostationary satellite = %d
        kilometer",a);
```

Scilab code Exa 29.2 The space shuttle a LEO satellite often orbits at an altitude of 250km What happens if the altitude of the shuttle becomes less than 250km

```
1 //Ex:2
2 clc;
3 clear;
4 close;
```

```

5 r_e=6378.14; //in km
6 h=250; //in km
7 a=r_e+h; //Radius of space shuttle orbit at 250km
  altitude in km
8 u=3.986*10^5; //kepler's const in km^3/sec^2
9 t_p=(4*pi^2*a^3/u)^(1/2); //in sec
10 printf("Time period of the orbit=%f sec", t_p);
11 printf("\nThe shuttle will slow down due to friction
  with earth atmosphere. Thus, the spacecraft
  will be in stable if its orbit period is more
  than 5370.30 sec");

```

Scilab code Exa 29.3 Determine the linear velocity of the shuttle along its orbit

```

1 //Ex:3
2 clc;
3 clear;
4 close;
5 a=6628.14; //Radius of space shuttle in km
6 T=5370.30 //Time period in sec
7 v_s=2*pi*a/T; //Velocity in km per sec
8 printf("Velocity of the shuttle =%f km per sec", v_s
  );

```

Scilab code Exa 29.4 A satellite is rotating in an elliptical orbit Calculate its orbital period

```

1 //Ex:4
2 clc;
3 clear;
4 close;
5 h_p=1000; //perigee height in km

```

```

6 h_a=4000; //apogee height in km
7 R_E=6378.14; // radius of earth in km
8 a=(2*R_E+h_p+h_a)/2; //Semi major axis in km
9 u=3.986*10^5 //km^3 per sec^2
10 T_P=(4*pi^2*a^3/u)^(1/2); //Orbit period in sec
11 printf("Orbital period =%f sec",T_P);

```

Scilab code Exa 29.5 Calculate the radius of the orbit

```

1 //Ex:5
2 clc;
3 clear;
4 close;
5 T=86400; //Orbital period in sec
6 u=3.986*10^5; //Kepler's const in km^3 per sec^2
7 a=(T^2*u/(4*pi^2))^(1/3); //Radius of orbital in km
8 printf("Radius of orbital =%d km",a);

```

Scilab code Exa 29.6 Estimate the rate of drift around the equator of the sub satellite in degree per day Is the satellite moving towards east or west

```

1 //Ex:6
2 clc;
3 clear;
4 close;
5 t_p=235.9; //Orbital period which is longer than a
   sidereal day in sec
6 d_r=360*t_p/86400; //Drift rate per day
7 printf("Drift rate =%f degree per day",d_r);
8 printf("\n Since the earth moves towards east ");

```

Scilab code Exa 29.7 Calculate the velocity of the satellite in orbit

```
1 //Ex:7
2 clc;
3 clear;
4 close;
5 h=1000; //Altitude in km
6 R_e=6378; //Radius of the earth in km
7 a=R_e+h; //Height of satellite from centre of the
    earth in km
8 u=3.986*10^5; //Kepler's const in km^3 per sec^2
9 T=(4*pi*pi*a^3/u)^(1/2); //Time period in km
10 v_s=((2*pi*a)/T);
11 printf("Velovity of satellite = %f km/s",v_s);
```

Scilab code Exa 29.8 calculate the component of velocity towards an observer at an earth station

```
1 //Ex:8
2 clc;
3 clear;
4 close;
5 r_e=6378; //radius of earth in km
6 h=1000; //altitude in km
7 cosx=r_e/(r_e+h);
8 v_s=7.35; //Velocity of satellite in km
9 v_tr=v_s*cosx; //component of satellite velocity
    towardsthe observer
10 printf("Component of the satellite velocity=%f km/
    sec",v_tr);
```

Scilab code Exa 29.9 Determine the doppler shift of the received signal at the earth station Discuss the impact of this shift on signal bandwidth

```

1 //Ex:9
2 clc;
3 clear;
4 close;
5 v_tr=6.354;//Velocity component of satellite
6 y=0.015// wavelength for Ka band tx with frequency
    20 gega hertz in meter
7 d_s=v_tr/y;//Doppler shift in khz
8 printf("Doppler shift =%f kHz",d_s);

```

Scilab code Exa 29.10 calculate the dimension of a reflector antenna

```

1 //Ex:10
2 clc;
3 clear;
4 close;
5 y=0.0272;//Wavelength in meter
6 db_x=6-2;//Bandwidth of an aperture antenna in
    degree
7 d=75*y/db_x;//dimension in m
8 printf("Dimension of an antenna=%f meter",d);

```

Scilab code Exa 29.11 Determine the receive power

```

1 //Ex:11
2 clc;
3 clear;
4 close;
5 eirp=21;//Eirp in db
6 g_r=50.5;//Receiving antenna gain in db
7 y=2.727*10^(-2);//Wavelength in m
8 h=4*10^7;//Height in m
9 p_l=20*log(4*%pi*h/y)/log(10);//Path loss in db

```

```
10 p_r=eirp+g_r-p_l;//received power in db
11 printf("Received power =%f db",p_r);
```

Scilab code Exa 29.12 Calculate the received power at earth station

```
1 //Ex:12
2 clc;
3 clear;
4 close;
5 p_t=13;//Tranponder output power in db w
6 b_t=1;//Transponder output backoff in db
7 g_t=30;//satellite antenna gain in db
8 g_r=59.2;//Earth station antenna gain in db
9 l_fs=195;//Free space loss in db
10 l_a=-2;//Edge of beam loss in db
11 l_air=0.2;//Air atmospheric loss in db
12 l_o=0.4;//Other losses in db
13 p_r=p_t+g_t+g_r-b_t-l_fs-l_a-l_air-l_o;//Received
    power in db w
14 printf("received power=%f db watt",p_r);
```

Scilab code Exa 29.13 Find the downlink noise power budget

```
1 //Ex:13
2 clc;
3 clear;
4 close;
5 k=-228.6;//Boltzman;s const in dbW/k/Hz
6 t_s=18.8;//System temp noise in db
7 b_n=74.3;//Noise bandwidth in db
8 n_r=k+b_n+t_s;//Receiver noise power in db watt
9 printf("Receiver noise power=%f db watt",n_r);
```

Scilab code Exa 29.14 Find CN ratio in the receiver in clear air

```
1 //Ex:14
2 clc;
3 clear;
4 close;
5 p_r=-96.4;//Received power in db watt
6 n_r=-135.5;//Receiver noise power in db watt
7 cn_r=p_r-n_r;//C/N ratio in db watt
8 printf("C/N ratio=%f db watt",cn_r);
```

Scilab code Exa 29.15 Find the earth station GT ratio

```
1 //Ex:15
2 clc;
3 clear;
4 close;
5 n_a=0.68;//Overall efficiency
6 d=30;//Diameter in m
7 f=4150*10^6;//Frequency in Hz
8 c=3*10^8;//Speed of light in m
9 y=c/f;//Wavelength in m
10 G_a=n_a*%pi^2*d^2/y^2;
11 G=10*log(G_a)/log(10);
12 t=19;// in db
13 printf("G/T ratio =%f db/k",G-t);
```

Scilab code Exa 29.16 Calculate the new GT ratio

```

1 //Ex:16
2 clc;
3 clear;
4 close;
5 t_s=10*log(88)/log(10); // in dbk
6 G=60.6; // in db
7 printf("G/T ratio =%f dbk",G-t_s);

```

Scilab code Exa 29.17 Bandwidth of satellite transponder is 36MHz Earth station use RRC filter Calculate the max bit rate

```

1 //Ex:17
2 clc;
3 clear;
4 close;
5 a=0.4; // roll_off factor
6 m=1; // for BPSK
7 B=36*m;
8 r_s=B/(1+a); // max bit rate in Mbps
9 printf("The max bit rate=%f Mbit/sec",r_s);

```

Scilab code Exa 29.18 calculate the max bit rate that can be sent through this transponder with QPSK

```

1 //Ex:18
2 clc;
3 clear;
4 close;
5 a=0.4; // roll_off factor
6 m=2; // for QPSK
7 B=36*m;
8 r_s=B/(1+a); // max bit rate in Mbps
9 printf("The max bit rate=%f Mbit/sec",r_s);

```

Scilab code Exa 29.19 Find the value of overall CN at the earth station

```
1 //Ex:19
2 clc;
3 clear;
4 close;
5 c_nu=316.22; //25; //c/n ratio for earth station
6 c_nd=100; //20; //c/n ratio from a transponder
7 c_n=1/((c_nu)^(-1)+(c_nd)^(-1)); //overall c/n ratio
8 printf("The overall c/n ratio=%f db ",c_n);
9 c_ndb=10*log(c_n)/log(10); //overall c/n ratio in db
10 printf("\n The overall c/n ratio=%f db", c_ndb);
```

Scilab code Exa 29.20 Calculate the power output of an uplink transmitter

```
1 //Ex:20
2 clc;
3 clear;
4 close;
5 g_t=26; //gain of satellite in db
6 l_s=207; //Path losses in db
7 l_ss=l_s+1.5+0.5+1.2; // all losses
8 g_r=50; // in db
9 p_o=10*log(1)/log(10); // output of the transponder
   in dbW
10 g_n=127; // linear gain in dbW
11 p_r=p_o-g_n; //received power in dbW
12 p_t=p_r-g_r-g_t+l_ss; //in dbW
13 printf(" Power output of an uplink transmitter=%f
   dbW ", p_t);
```

```

14 p_tW=10^(p_t/10);
15 printf("\n Power output of an uplink tarnsmitter=%f
    W",p_tW);

```

Scilab code Exa 29.21 find output power rating required for the transmitter

```

1 //Ex:21
2 clc;
3 clear;
4 close;
5 p_tr=7.2+7;//transmitted power when rain attenuation
    of 7db
6 printf("Transmitted power=%f dbW", p_tr);

```

Scilab code Exa 29.22 Calculate the uplink transmitter power required

```

1 //Ex:22
2 clc;
3 clear;
4 close;
5 k=-228.6;//Boltzmann's const in dbW/K/Hz
6 t_s=10*log(500)/log(10);//in db
7 B=10*log(43.2*10^6)/log(10);//in dbHz
8 n_tr=k+t_s+B;//Transponder noise power in dbW
9 p_r=n_tr+30;//received power at the transponder
    input must be 30 db greater than noise power in
    db
10 g_st=16.2;//Satellite antenna gain in db
11 g_est=25;//Earth statiion antenna gain in db
12 p_rs=95.2;// in db
13 l_ss=207+3;//Losses in db
14 p_t=p_rs+g_st+g_est-l_ss;

```

```
15 printf("Required transmitted power=%f dbW", p_t);
```

Scilab code Exa 29.23 Calculate the symbol rate

```
1 //Ex:23
2 clc;
3 clear;
4 close;
5 B_s=10^6; //B.W. in Hz
6 a=0.5; //Roll_off of a filter
7 r_sym=B_s/(1+a); //Symbol rate in bps
8 printf("Symbol rate =%f bit/sec", r_sym);
9 printf("\n Symbol rate =%f Kbit/sec", r_sym/1000);
```

Scilab code Exa 29.24 Estimate the BW occupied by the RF signal and the frequency range of transmitted signal

```
1 //Ex:24
2 clc;
3 clear;
4 close;
5 a=0.25; //Roll_off
6 r_s=16*10^3; //Symbol rate in Hz
7 B_s=r_s*(1+a); //signal BW in Hz
8 f_c=14.125*10^6; // in Hz
9 f_min=f_c-(B_s)/2; //min frequency in Hz
10 f_max=f_c+(B_s)/2; //max frequency in Hz
11 //printf("min frequency=%f MHz", B_s);
12 printf("min frequency=%f MHz", f_min/10^6);
13 printf("\n max frequency=%f MHz", f_max/10^6);
14 //Hence frequency range of transmitted signal is
    from 14.115 MHz to 14.135 MHz
```

Scilab code Exa 29.25 Calculate the required carrier to noise ratio

```
1 //Ex:25
2 clc;
3 clear;
4 close;
5 r_b=10*log(60*10^6)/log(10); //in db Hz
6 Eb_n=8; //Energy per bit to noise power density in db
7 c_n=Eb_n+r_b; //in db
8 printf("The C/N ratio=%f db",c_n);
```

Scilab code Exa 29.26 Calculate the earth station transmitter power needed for transmission of a baseband signal

```
1 //Ex:26
2 clc;
3 clear;
4 close;
5 r_b=10*log(1.544*10^6)/log(10); //bit rate in db bit/
   s
6 Eb_n=9; //Eb/No in db
7 c_n=Eb_n+r_b; //C/N ratio in db
8 c_ns=71; //in db
9 g_t=-8; //G/T ratio in db
10 l_s=210; //Losses in db
11 k=228.6; //in db
12 e_rp=c_ns+g_t+l_s-k
13 G_upa=42; //uplink antenna gain in db
14 p_t=e_rp-G_upa; // in dbW
15 p_t1=10^(p_t); // in Watt
16 printf("required power =%f dbW",p_t);
17 printf("\n required power =%f Watt",p_t1);
```

Scilab code Exa 29.27 Calculate the uplink power increase required for TDMA operation

```
1 //Ex:27
2 clc;
3 clear;
4 close;
5 r_b=62; //bit rate in db bits/s
6 r_bu=71-62; //uplink bit rate increase
7 p_up=2.4+r_bu; //Earth station transmitted power in
  dbW
8 printf("The earth station transmitted power =%f dbw"
  ,p_up);
```

Scilab code Exa 29.28 Calculate the EIRP of a satellite downlink

```
1 //Ex:28
2 clc;
3 clear;
4 close;
5 p_s=10*log(6)/log(10); //transmit power in db
6 g_a=50.2; // Antenna gain in db
7 e_rp=p_s+g_a; //EIRP in dbW
8 printf("The EIRP=%f dbW" , e_rp);
```

Scilab code Exa 29.29 Calculate the gain of 3 m paraboloidal antenna

```
1 //Ex:29
2 clc;
```

```

3 clear;
4 close;
5 u=0.55; //aperture efficiency
6 f=12; // in GHz
7 d=3; // diameter in m
8 G_i=u*(10.472*f*d)^2;
9 g=ceil(G_i);
10 g_i=10*log(g)/log(10); //in db
11 printf("Gain=%f ", g_i);

```

Scilab code Exa 29.30 Calculate the overall noise temperature of the system

```

1 //Ex:30
2 clc;
3 clear;
4 close;
5 t_a=35; //antenna noise temp in K
6 f=12; //receiver noise figure in db
7 F=10^(12/10); //receiver noise figure
8 l_c=10^(5/10); //cable loss
9 g_lna=10^5; //LNA gain
10 t_lna=150; //noise temp in K
11 t_o=290; // in K
12 t_s=t_a+t_lna+(l_c-1)*t_o/g_lna+l_c*(F-1)*t_o/g_lna;
13 printf("Gain=%d K", t_s);

```

Scilab code Exa 29.31 Calculate the carrier to noise spectral density ratio

```

1 //Ex:31
2 clc;
3 clear;
4 close;

```



```

5 k=-228.6; // in db
6 e_irp=50; // EIRP in dbW
7 g_t=19.5; //G/T ratio in db/k
8 l_fs=210; //free space loss in db
9 l_ab=2; //atmospheric absorption loss in db
10 l_ap=2; //antenna pointing loss in db
11 l_rf=1; //receiver feedback loss in db
12 l_s=l_fs+l_ab+l_ap+l_rf; //losses in db
13 c_n=e_irp+g_t-l_s-k; // C/N spectral density ratio in
    db
14 printf("carrier to noise spectral density ratio=%d
    dbW",c_n);

```

Scilab code Exa 29.32 Calculate the earth station EIRP required for saturation assuming clear sky conditions

```

1 //Ex:32
2 clc;
3 clear;
4 close;
5 f=14; //frequency
6 A_o=-(21.45+20*log(f)/log(10)); //effective area in
    db
7 y_str=-100; //flux density required to saturate the
    transponder in db
8 l_s=200; //free space losses in db
9 e_irp=y_str+A_o+l_s; //the earth station EIRP
    required for saturation in dbw
10 printf("the earth station EIRP required for
    saturation=%f dbW",e_irp);

```

Scilab code Exa 29.33 Calculate the effective isotropic radiated power in watts as seen by the antenna

```

1 //Ex:33
2 clc;
3 clear;
4 close;
5 e_irp=52; //EIRP in dbW
6 p_s=10^(e_irp/10); //effective isotropic radiated
   power in W
7 printf("effective isotropic radiated power=%f KW",
   p_s/1000);

```

Scilab code Exa 29.34 Calculate the noise power for a BW of 36 MHz

```

1 //Ex:34
2 clc;
3 clear;
4 close;
5 t_a=40; // noise temp in K
6 t_r=100; //receiver noise temp in K
7 t_n=t_a+t_r; //total noise temp in K
8 B_n=36*10^6; //BW in Hz
9 k=1.38*10^(-23); // Boltzmann's const in J/K
10 p_n=k*t_n*B_n; //noise power in W
11 printf("noise power=%f pW", p_n/(10^(-12)));

```

Scilab code Exa 29.35 Calculate the total link loss

```

1 //Ex:35
2 clc;
3 clear;
4 close;
5 l_fs=202; //free space loss in db
6 l_ab=0.5; //atmospheric absorption loss in db
7 l_ap=1; //antenna pointing loss in db

```

```

8 l_rf=2; //receiver feedback loss in db
9 l_s=l_fs+l_ab+l_ap+l_rf; //losses in db
10 printf("the total link loss=%f db",l_s);

```

Scilab code Exa 29.36 Calculate the clear sky carrier to noise ratio for a satellite TV system having worst case EIRP of 51 dbw

```

1 //Ex:36
2 clc;
3 clear;
4 close;
5 e_irp=51; // EIRP in dbW
6 g_t=13.12; //G/T ratio in db/k
7 l_fs=205.34; //free space loss in db
8 l_ab=0.17; //atmospheric absorption loss in db
9 df=16; // in MHz
10 f_v=5; // in MHz
11 B=df+2*f_v; // in MHz
12 k=1.38*10^(-23); // Boltzmann's const in J/K
13 k_b=k*B*10^6;
14 kB=10*log(k_b)/log(10);
15 c_n=e_irp-l_fs+g_t-l_ab-kB;
16 printf("carrier to noise ratio=%f dbw",c_n);

```

Scilab code Exa 29.37 Calculate the transmission bit rate for stop and wait system

```

1 //Ex:37
2 clc;
3 clear;
4 close;
5 d_r=24; //Data rate in Kbits/s
6 t_b=1/(d_r*10^3); //bit time in sec

```

```

7 t_bi=.0005; // in sec
8 p_d=2*0.240; //path delay in sec
9 printf("Waiting of ack takes place %f sec", t_bi+p_d
);
10 t_ack=p_d+t_bi; //Acknowledgement time in sec
11 n_b=79; // number of blocks
12 t_tr=n_b/2; //Time taken for transmission in sec
13 r_b=(n_b*127)/t_tr; //bit transmission rate in bits/s
14 printf("\n bit transmission rate =%f bits/s",r_b);

```

Scilab code Exa 29.38 what should be the capacity of the transmit buffer

```

1 //Ex:38
2 clc;
3 clear;
4 close;
5 t_r=(79*127)/(24*10^3); //Time required to transmit
    79 blocks in sec
6 t_pb=t_r/79; //Transmission time per block
7 n_b=0.48/t_pb; //no. of blocks which arrive at the
    receiver
8 n_B=ceil(n_b);
9 c_r=n_B*127; //the required capacity in bits
10 printf("The required capacity=%d bits",c_r);

```

Scilab code Exa 29.39 Calculate the transmission bit rate for Selective Repeat ARQ system

```

1 //Ex:39
2 clc;
3 clear;
4 close;
5 n_b=79-1; //no. of blocks in this system

```

```

6 r_eff=n_b/79;//rate efficiency
7 r_b=24*r_eff;//bit tkbits/sransmission rate in
8 printf("Bit transmission rate =%f Kbits/s",r_b);

```

Scilab code Exa 29.40 Calculate the noise power in transponder1 or in the inbound SCPC FDMA channels

```

1 //Ex:40
2 clc;
3 clear;
4 close;
5 k=-228.6;//dbW/K/Hz
6 b_n=10*log(128*(10^3))/log(10);// in dbHz
7 t_s=10*log(500)/log(10);//in dbk
8 t_S=ceil(t_s);
9 n_tr=k+t_S+b_n;// in dbW
10 printf("noise power=%f dbW",n_tr);

```

Scilab code Exa 29.41 Calculate the noise power in the hub station receiver or in inbound SCPC FDMA channel

```

1 //Ex:41
2 clc;
3 clear;
4 close;
5 k=-228.6;// in db
6 t_s=10*log(150)/log(10);// in dbK
7 b_n=51.1;// in dbHz
8 n_h=k+t_s+b_n;//the noise power in the hub station
   receiver in dbw
9 printf("noise power=%f dbW",n_h);

```

Scilab code Exa 29.42 Calculate the noise power in transponder2

```
1 //Ex:42
2 clc;
3 clear;
4 close;
5 b_n=10*log(10^6)/log(10); // in dbHz
6 t_s=10*log(500)/log(10); //temp in dbK
7 T_s=ceil(t_s);
8 k=-228.6; // in db
9 n_rt=k+b_n+T_s; //the noise power in transponder-2 in
   dbW
10 printf("the noise power in transponder-2=%f dbW",
   n_rt);
```

Scilab code Exa 29.43 Calculate the noise power in the VSAT receivers

```
1 //Ex:43
2 clc;
3 clear;
4 close;
5 k=-228.6; // in db
6 t_s=10*log(150)/log(10); // temp in dbK
7 b_n=10*log(10^6)/log(10); // in dbHz
8 n_h=k+t_s+b_n; //the noise power in the VSAT in dbW
9 printf("the noise power in the VSAT=%f dbW", n_h);
```

Scilab code Exa 29.44 Calculate the power received at the satellite transmitted from the VSAT uplink

```

1 //Ex:44
2 clc;
3 clear;
4 close;
5 p_t=10*log(2)/log(10); // transmit power in dbW
6 g_t=42; // Gain of the VSAT transmit antenna in db
7 g_r=30; //Gain of the satellite receive antenna in db
8 l_p=207; //Free space path loss at 14HGz
9 l_b=2; //Beam loss in db
10 l_a=0.5; //atmospheric loss in db
11 l_l=0.5; //miscellaneous loss in db
12 l_o=l_b+l_a+l_l; // other losses in db
13 p_r=p_t+g_t+g_r-l_p-l_o; //the power received in dbW
14 P_r=floor(p_r);
15 printf("The power received=%f dbW",P_r);

```

Scilab code Exa 29.45 Calculate the uplink inbound CN ratio in transponder1

```

1 //Ex:45
2 clc;
3 clear;
4 close;
5 p_tr1=-135; //power received in transponder-1 in dbW
6 n_tr1=-150.5; //noise power in transponder-1 in dbw
7 c_n=p_tr1-n_tr1; //C/N ratio in db
8 printf("The C/N ratio=%f db",c_n);

```

Scilab code Exa 29.46 Calculate the max number of VSAT channels that can be handled by the system

```

1 //Ex:46
2 clc;

```

```

3 clear;
4 close;
5 p_ts=10*log(20)/log(10); //saturated transponder
    power in dbw
6 b=2; //back_off in db
7 p_b=p_ts-b; //power becomes with back_off in db
8 p_B=floor(p_b);
9 P_b=10^(p_B/10); //Power becomes with back_off
10 n_c=P_b/1; //no. of channels
11 n_cs=floor(n_c);
12 printf("The max no. of VSAT channels=%f",n_cs);

```

Scilab code Exa 29.47 Calculate the centrifugal force for a satellite of mass 100 kg orbiting with a velocity of 8 km per s at a height of 200 km

```

1 //Ex:47
2 clc;
3 clear;
4 close;
5 m=100; //mass in kg
6 v=8000; //velocity in m/s
7 r=6370*10^3; //radius of earth in m
8 h=200*10^3; //height above the earth surface in m
9 c_f=(m*v^2)/(r+h); //centrifugal force in newtons
10 printf("The centrifugal force=%d newtons",c_f);

```

Scilab code Exa 29.48 Determine the orbital velocity of a satellite moving in a circular orbit at a height of 150 km

```

1 //Ex:48
2 clc;
3 clear;
4 close;

```



```

5 G=6.67*10^(-11); // Gravitation const in N-m^2/kg^2
6 r_e=6370*10^3; // radius of earth in m
7 h=150*10^3; // height in m
8 m=5.98*10^24; // mass of earth in kg
9 u=G*m;
10 v=sqrt(u/(r_e+h))/1000; // velocity in km/s
11 printf("The orbital velocity of a satellite=%f km/s"
    ,v);

```

Scilab code Exa 29.49 Determine the semi major axis of elliptical orbit

```

1 //Ex:49
2 clc;
3 clear;
4 close;
5 r_a=30000; // apogee in km
6 r_p=1000; // perigee in km
7 a=(r_a+r_p)/2; // Semi-major axis in km
8 printf("The semi-major axis=%f km",a);

```

Scilab code Exa 29.50 Determine the orbital eccentricity

```

1 //Ex:50
2 clc;
3 clear;
4 close;
5 a_p=30000; // the difference b/w apogee and perigee
    in km
6 a=16000; // Semi-major axis in km
7 e=a_p/(2*a); // orbital eccentricity
8 printf("The orbital eccentricity=%f",e);

```

Scilab code Exa 29.51 Determine the apogee the perigee and eccentricity

```
1 //Ex:51
2 clc;
3 clear;
4 close;
5 r_a=30000+6370;//apogee in km
6 r_p=200+6370;//perigee in km
7 e=(r_a-r_p)/(r_a+r_p);// eccentricity
8 printf("The apogee=%f km",r_a);
9 printf("\n The perigee=%f km",r_p);
10 printf("\n The orbital eccentricity=%f",e);
```

Scilab code Exa 29.52 Determine the apogee and perigee distance

```
1 //Ex:52
2 clc;
3 clear;
4 close;
5 e=0.5;//orbital eccentricity
6 a_e=14000;//dis b/w center of ellipse to the center
   of earth in km
7 a=a_e/e;//semi major axis in km
8 r_a=a*(1+e);//apogee in km
9 r_p=a*(1-e);//perigee in km
10 printf("The apogee=%d km",r_a);
11 printf("\n The perigee=%d km",r_p);
```

Scilab code Exa 29.53 Determine the relationship between their orbital periods

```

1 //Ex:53
2 clc;
3 clear;
4 close;
5 G=6.67*10^(-11); // Gravitation const in N-m^2/kg^2
6 a_1=18000; //semi major axis for satellite -1
7 a_2=24000; //semi major axis for satellite -2
8 t2_t1=(a_2/a_1)^(3/2); //The ratio of orbital periods
    of given two satellite
9 printf("Orbital periods ratio of two satellite =%f",
    t2_t1);
10 printf("\n thus orbital period of satellite_2 is
    1.54 times that of satellite_1");

```

Scilab code Exa 29.54 Determine the escape velocity for an object to be launched from surface of earth

```

1 //Ex:54
2 clc;
3 clear;
4 close;
5 G=6.67*10^(-11); // Gravitation const in N-m^2/kg^2
6 r_e=6370*10^3; //radius of earth in m
7 m=5.98*10^24; //mass of earth in kg
8 u=G*m;
9 v_e=sqrt((2*u)/r_e); //escape velocity in km/s
10 printf("The escape velocity=%f km/s", v_e/1000);

```

Scilab code Exa 29.55 Calculate the period of a satellite in an eccentric elliptical orbit

```

1 //Ex:55
2 clc;

```

```

3 clear;
4 close;
5 a=50000*1000/2; //semi major axis in km
6 G=6.67*10^(-11); //Gravitation const in N-m^2/kg^2
7 m=5.98*10^24; //mass of earth in kg
8 u=G*m;
9 st=sqrt((a^3)/u);
10 s_t=6.25*10^3;
11 t=2*(3.14)*s_t;
12 printf("The period of a satellite=%f s",t);
13 printf("\n The period of a satellite is 10 hours 54
    minutes");

```

Scilab code Exa 29.56 Determine the orbital time period and the velocity at the apogee and perigee point

```

1 //Ex:56
2 clc;
3 clear;
4 close;
5 r_a=35000+6360; //apogee in km
6 r_p=500+6360; //perigee in km
7 A=(r_a+r_p)/2; //Semi-major axis in km
8 a=A*1000; //Semi-major axis in m
9 G=6.67*10^(-11); //Gravitation const in N-m^2/kg^2
10 m=5.98*10^24; //mass of earth in kg
11 u=G*m;
12 t=2*(3.14)*sqrt((a^3)/u);
13 printf("The orbital time period=%d s",t);
14 printf("\n The orbital time period is 10 hours 20
    minutes");
15 x=2/(r_a*1000);
16 y=1/a;
17 v_a=sqrt(u*(x-y)); // velocity at apogee in m/s
18 c=2/(r_p*1000);

```

```

19 v_p=sqrt(u*(c-y)); // velocity at perigee in m/s
20 printf("\n The velocity at apogee=%d m/s",v_a);
21 printf("\n The velocity at perigee=%f km/s",v_p
    /1000);

```

Scilab code Exa 29.57 Determine the target eccentricity

```

1 //Ex:57
2 clc;
3 clear;
4 close;
5 d_ap=30000; //Difference of apogee and perigee dis in
    km
6 s_ap=50000; //sum of apogee and perigee dis in km
7 e=d_ap/s_ap;
8 printf("The orbital eccentricity=%f",e);

```

Scilab code Exa 29.58 Determine the apogee the perigee and eccentricity

```

1 //Ex:58
2 clc;
3 clear;
4 close;
5 a=20000; //apogee in km
6 b=16000; //perigee in km
7 x=2*a; //sum of apogee and perigee
8 B=-40000;
9 A=1
10 C=256000000;
11 r_a1=(-B+sqrt(B^2-(4*A*C)))/2;
12 printf("The apogee distance=%d km",r_a1);
13 r_p1=x-r_a1;
14 printf("\n The perigee distance=%d km",r_p1);

```

Scilab code Exa 29.59 Determine the orbital period

```
1 //Ex:59
2 clc;
3 clear;
4 close;
5 G=6.67*10^(-11); // Gravitation const in N-m^2/kg^2
6 r_e=6360*10^3; // radius of earth in m
7 h=640*10^3; // height in m
8 m=5.98*10^24; // mass of earth in kg
9 u=G*m;
10 v=sqrt(u/(r_e+h)); // velocity in km/s
11 V=7.54; // km/s
12 t=(2*3.14*(r_e+h)/1000)/V;
13 printf("The orbital period=%d s",t);
14 printf("\n The orbital period is 1 hour 37 minutes")
    ;
```

Scilab code Exa 29.60 What will be the time taken by the satellite to move from A to B in the direction shown in figure

```
1 //Ex:60
2 clc;
3 clear;
4 close;
5 t_s=3+(10/60); // in hours
6 //Area B to A=Area of half of ellipse - Area of
    triangle(AOB);
7 // =(pi*a*b)/2 - (b*OC) from given figure
    ;
8 // =(pi*a*b)/2 - (b*a*e);
```

```

9 // =0.97*a*b;
10 //Area A to B=(pi*a*b)/2+0.6*a*b=2.2*a*b;
11 //The ratio of two areas is=2.2;
12 t=2.2*t_s;// time taken in hours
13 T=ceil(t);
14 printf("The time taken=%d hours", T);

```

Scilab code Exa 29.61 Determine the semi major axis and semi minor axis and the orbit eccentricity

```

1 //Ex:61
2 clc;
3 clear;
4 close;
5 r_a=50000;//apogee in km
6 r_p=8000;//perigee in km
7 a=(r_a+r_p)/2;//Semi-major axis in km
8 b=sqrt(r_a*r_p);//semi minor axis in km
9 e=(r_a-r_p)/(r_a+r_p);//eccentricity
10 printf("The semi-major axis=%f km",a);
11 printf("\n The semi-minor axis=%f km",b);
12 printf("\n The eccentricity=%f km",e);

```

Scilab code Exa 29.62 Determine the orbital period of satellite2

```

1 //Ex:62
2 clc;
3 clear;
4 close;
5 G=6.67*10^(-11);//Gravitation const in N-m^2/kg^2
6 a_1=16000;//semi major axis for satellite-1
7 a_2=24000;//semi major axis for satellite-2
8 t1=10;//the orbital period of satellite-1 in hours

```

```

9 t2=t1*(a_2/a_1)^(3/2); //The ratio of orbital periods
    of given two satellite
10 printf("Orbital periods of satellite -2=%f hours",t2)
    ;

```

Scilab code Exa 29.63 Calculate the max deviation in latitude and also determine the max displacement in kms

```

1 //Ex:63
2 clc;
3 clear;
4 close;
5 h=35800; //height in km
6 r=6364; //earth's radius in km
7 r_o=r+h; //orbital radius in km
8 i=2; //angle of inclination in degree
9 w_m=0.0175;
10 y_m=i; //max latitude deviation
11 d_m=r_o*i*(3.14/180); //max displacement due to
    latitude deviation in km
12 D_m=d_m*(w_m/y_m); //max displacement due to
    longitude deviation in km
13 printf("max displacement due to latitude deviation=
    %d km",d_m);
14 printf("\n max displacement due to longitude
    deviation=%f km",D_m);

```

Scilab code Exa 29.64 Determine the magnitude of velocity impulse needed to correct the inclination of 2 degree

```

1 //Ex:64
2 clc;
3 clear;

```



```

4 close;
5 u=39.8*10^13;
6 r=42164*10^3;
7 i=2*(3.14/180); //angle of inclination in degree
8 a=(sqrt(u/r))*tan(i); //the magnitude of velocity
    impulse in m/s
9 printf("The magnitude of velocity impulse=%d m/s",a)
    ;

```

Scilab code Exa 29.65 Determine the angle of inclination between the new orbital plane and the equatorial

```

1 //Ex:65
2 clc;
3 clear;
4 close;
5 r=42164; // in km
6 d_m=500; // in km
7 i=d_m/r; // the angle of inclination in rad
8 printf("The angle of inclination=%f rad",i);
9 printf("\n The angle of inclination=%f degree",i
    *(180/3.14));

```

Scilab code Exa 29.66 Determine the theoretical max coverage angle also determine the max slant range

```

1 //Ex:66
2 clc;
3 clear;
4 close;
5 r=6378; //radius of earth in km
6 h=35786; // in km
7 r_h=r+h; //height in km

```

```

8 E_min=0; // in degree
9 P=cos(E_min*3.14/180);
10 Q=(r/(r_h)*P);
11 a_mx=(asin(Q))*(180/3.14); //the theoretical max
    coverage angle in degree
12 D=(r^2)+(r_h^2)-2*r*r_h*sin(a_mx*3.14/180);
13 d=sqrt(D); // in km
14 d1=ceil(d); //max slant range in km
15 printf("The theoretical max coverage angle=%f degree
    ", a_mx);
16 printf("\n The max slant range=%d km", d1);

```

Scilab code Exa 29.67 What would be the new max coverage angle and the slant range

```

1 //Ex:67
2 clc;
3 clear;
4 close;
5 R_e=6378; // in km
6 H=35786; // in km
7 E_min=5; // min elevation angle in degree
8 x=cos(E_min*3.14/180);
9 R=R_e/(R_e+H);
10 P=2*asin(R*x); // in radian
11 a_max=(P)*180/3.14; // in degree
12 printf("The max coverage angle=%f degree", a_max);

```

Scilab code Exa 29.68 Calculate the angle subtended by the arc of the satellite footprint at the center of the earth

```

1 //Ex:68
2 clc;

```

```

3 clear;
4 close;
5 R_e=6378; // in km
6 H=35786; // in km
7 E1=5; // min elevation angle in degree
8 E2=0; // min elevation angle in degree
9 x1=cos(E1*3.14/180);
10 x2=cos(E2*3.14/180);
11 R=R_e/(R_e+H);
12 P1=asin(R*x1); // in radian
13 P2=asin(R*x2); // in radian
14 a1=(P1)*180/3.14; // in degree
15 a2=(P2)*180/3.14; // in degree
16 y=175-(a1+a2);
17 printf("The angle subtended=%f degree", y);

```

Scilab code Exa 29.69 Determine the round trip delay for an earth station

```

1 //Ex:69
2 clc;
3 clear;
4 close;
5 r=6378; //radius of earth in km
6 h=35786; // in km
7 r_h=r+h; //height in km
8 E_min=5; // in degree
9 P=cos(E_min*3.14/180);
10 Q=(r/(r_h)*P);
11 a_mx=(asin(Q))*(180/3.14); //the theoretical max
    coverage angle in degree
12 a_mx1=E_min+a_mx;
13 D=(r^2)+(r_h^2)-2*r*r_h*sin(a_mx1*3.14/180);
14 d=sqrt(D); // in km
15 d1=ceil(d); //max slant range in km
16 c=3*10^5; // in m/s

```

```
17 t=2*d1/c;
18 printf("The round trip delay=%f millisecc",t*1000);
```

Scilab code Exa 29.70 Determine the max shadow angle that occurs at equinoxes for a satellite orbiting in a circular equatorial orbit at a height of 13622 km above the surface of earth also determine the max daily eclipse duration

```
1 //Ex:70
2 clc;
3 clear;
4 close;
5 r=6378; //radius of earth in km
6 r_o=r+13622; // radius of orbit in km
7 s_mx=180-2*(acos(r/r_o))*(180/%pi); //the max shadow
   angle in degree
8 t_e=(s_mx/360)*24; // max daily eclipse duration in
   hours
9 printf("The max shadow angle=%f degree",s_mx);
10 printf("\n The max daily eclipse duration=%f hours",
   t_e);
```

Scilab code Exa 29.71 Determine the total time from the first day of eclipse to the last day also determine the same for geostationary orbit at a height of 35786 km

```
1 //Ex:71
2 clc;
3 clear;
4 close;
5 r=6378; //radius of earth in km
6 h=35786; // height in km
7 r_o=2000; // in km
```

```

8 x=37.4; // in degree
9 i_e=x/2; // in degree
10 y=asin(i_e/23.4);
11 y1=y*180/%pi; // in degree
12 y2=floor(y1);
13 t=(365*y2*%pi)/(2*%pi*180); // in days
14 A=acos(r/(r+h));
15 B=A*180/%pi; // in degree
16 y_mx=180-2*B;
17 C=(asin((y_mx/2)/23.4))*(180/%pi); // in degree
18 t2=(365*C*%pi)/(2*%pi*180); // in days
19 printf("The total time of eclipse=%f days",t);
20 printf("\n The total time for geostationary orbit=%f
    hours",t2);

```

Scilab code Exa 29.72 Calculate the incremental velocity to be given to the satellite at the apogee point by the apogee kick motor to circularize the orbit

```

1 //Ex:72
2 clc;
3 clear;
4 close;
5 R=6378; //radius of earth in km
6 h=35786; // height in km
7 r=R+h; //in km
8 a=(2*R+35786+300)/2; //semi major axis in km
9 u=39.8*10^13; //N-sq.m/kg
10 v_a=sqrt(u*((2/r*1000)-(1/a*1000))); //m/s
11 V_a=v_a/1000000; //km/s
12 v_c=sqrt(u/r*1000);
13 dv=v_c/1000000-V_a; //incremental velocity
14 printf("The incremental velocity=%f km/s",dv);

```

Scilab code Exa 29.73 Determine the velocity change required to circularize the orbit

```
1 //Ex:73
2 clc;
3 clear;
4 close;
5 i=28; // in degree
6 v_a=1.61; // in km/s
7 v_c=3.07; // in km/s
8 x=cos(i*3.14/180);
9 dv=sqrt(v_a^2+v_c^2-2*v_a*v_c*x);
10 printf("The velocity change=%f km/s",dv);
```

Scilab code Exa 29.74 Determine the max line of sight distance between two communication satellites

```
1 //Ex:74
2 clc;
3 clear;
4 close;
5 printf("OA=AC. sinx=(R+H) sinx");
6 printf("\n x=acos(R/(R+H))");
7 printf("\n Therefore");
8 printf("\n OA=(R+H) sin(acos(R/(R+H)))");
9 printf("\n Max line of sight=2.OA");
10 printf("\n Max line of sight=2(R+H) sin(acos(R/(R+H)))");
```

Scilab code Exa 29.75 Determine the max line of sight distance and also for geostationary satellites

```
1 //Ex:75
2 clc;
3 clear;
4 close;
5 R=6370; // Radius of earth in km
6 x=(R/(R+R));
7 y=(acos(x))*(180/%pi);
8 d_mx=2*2*R*sin(y*%pi/180);
9 R_H=42164; // in km
10 x1=(R/(R_H));
11 y1=(acos(x1))*(180/%pi);
12 d_mx1=2*R_H*sin(y1*%pi/180);
13 printf("The max line of sight distance=%d km", d_mx)
    ;
14 printf("\n The max line of sight distance for
    geostationary satellites=%f km", d_mx1);
```

Scilab code Exa 29.76 Find the round trip propagation delay

```
1 //Ex:76
2 clc;
3 clear;
4 close;
5 a_d=130-70; //angular difference in degree
6 printf("The line of sight distance(AB) b/w the two
    satellites in given figure");
7 printf("\n sq(AB)=sq(AC)+sq(BC)-2AC*BC*cos(60)");
8 printf("\n AC=BC=R.....(orbital radius)");
9 printf("\n sq(AB)=sq(R)+sq(R)-2*sq(R)*(0.5)");
10 printf("\n AB=R");
11 printf("\n Round trip time=(2R/(3*10^8))");
```

Scilab code Exa 29.77 Determine the round trip propagation delay

```
1 //Ex:77
2 clc;
3 clear;
4 close;
5 a_d=30+15; //angular difference in degree
6 R=10000; //orbital radius in km
7 l_s=sqrt((R^2)+(R^2)-2*(R^2)*cos(45*3.14/180));
8 R_tp=(2*l_s)/(3*10^5);
9 printf("The round trip propagation delay=%f sec",
    R_tp);
10 printf("\n The round trip propagation delay=%f
    millisec", ceil(R_tp*1000));
```

Scilab code Exa 29.78 Determine the earth station azimuth and elevation angles

```
1 //Ex:78
2 clc;
3 clear;
4 close;
5 R=6378; // Radius of earth in km
6 R_o=42164; //orbital radius in km
7 A1=(atan(tan(20*%pi/180)/(sin(60*%pi/180))))*(180/
    %pi); // in degree
8 A=180-A1; //Azimuth angle in degree
9 x_sl=20*%pi/180; //Diff b/t satellite longitude &
    earth station longitude in radians
10 x_l=60*%pi/180; //earth station latitude in radian
11 B=cos(x_sl)*cos(x_l);
12 s=(acos(B))*(180/%pi);
```



```

13 s1=R*sin(s*pi/180);
14 s2=R_o-R*B;
15 E=(atan(s2/s1))*(180/%pi)-s;
16 printf("The Azimuth angle=%f degree", A);
17 printf("\n The elevation angle=%f degree", E);

```

Scilab code Exa 29.79 Determine the max eclipse time in a day during the full eclipse period

```

1 //Ex:79
2 clc;
3 clear;
4 close;
5 R=6378; // Radius of earth in km
6 H=10000; // in km
7 A=(R/(R+H));
8 A1=(acos(A))*(180/%pi);
9 y_m=180-2*A1;
10 y_m1=ceil(y_m);
11 u=39.8*10^13; // in N sq.m/kg
12 a=(R+H)*1000; // in m
13 p_o=2*pi*sqrt((a)^3/(u)); // orbital period in sec
14 p_o1=p_o/3600; // orbital period in hours
15 t_e=(y_m1/360)*p_o1; // eclipse duration in hours
16 t_e1=t_e*60; // eclipse duration in min
17 printf("The eclipse duration=%f hours", t_e);
18 printf("\n The eclipse duration=%f minutes", t_e1);

```

Scilab code Exa 29.80 Determine the incremental velocity required to correct the orbit inclination

```

1 //Ex:80
2 clc;

```

```

3 clear;
4 close;
5 i=5.3; // in degree
6 v_a=1.61; // in km/s
7 v_c=3.07; // in km/s
8 x=cos(i*3.14/180);
9 dv=sqrt(v_a^2+v_c^2-2*v_a*v_c*x);
10 printf("The incremental velocity=%f km/s",dv);

```

Scilab code Exa 29.81 Determine the earth station azimuth and elevation angles

```

1 //Ex:81
2 clc;
3 clear;
4 close;
5 R=6378; // Radius of earth in km
6 R_o=42164; //orbital radius in km
7 x_s1=(105-60)*%pi/180; //Diff b/t satellite longitude
    & earth station longitude in radians
8 x_l=30*%pi/180; //earth station latitude in radian
9 B=cos(x_s1)*cos(x_l);
10 s=(acos(B))*(180/%pi);
11 s1=R*sin(s*%pi/180);
12 s2=R_o-R*B;
13 E_a=(atan(s2/s1))*(180/%pi)-s;
14 x_s11=(105-90)*%pi/180; //Diff b/t satellite
    longitude & earth station longitude in radians
15 x_l1=45*%pi/180; //earth station latitude in radian
16 B1=cos(x_s11)*cos(x_l1);
17 so=(acos(B1))*(180/%pi);
18 s3=R*sin(so*%pi/180);
19 s4=R_o-R*B1;
20 E_b=(atan(s4/s3))*(180/%pi)-so;
21 E_b=floor(E_b);

```

```

22 E_a1=E_a*%pi/180; // Ea in rad
23 E_b2=E_b*%pi/180; // Eb in rad
24 L1=(R/R_o)*cos(E_a1); // in rad
25 M1=(asin(L1))*(180/3.14); // in rad
26 N1=(E_a+M1)*(%pi/180);
27 nm1=sin(N1);
28 d1=(R_o^2)+(R^2)-2*R*R_o*nm1;
29 d_a=sqrt(d1);
30 L2=(R/R_o)*cos(E_b2); // in rad
31 M2=(asin(L2))*(180/%pi); // in rad
32 N2=(E_b+M2)*(3.14/180);
33 nm2=sin(N2);
34 d2=(R_o^2)+(R^2)-2*R*R_o*nm2;
35 d_a2=sqrt(d2);
36 r_c=d_a+d_a2;
37 p_d=r_c/(3*10^5);
38 p_d1=p_d*1000;
39 s_tr=500000/10000; // in millisec
40 T_pd=p_d1+s_tr; // Total propagation delay in
    millisec
41 printf("The Total propagation delay=%f millisec",
    T_pd);

```

Scilab code Exa 29.82 Calculate the power gain of a paraboloid reflector antenna with a mouth dia of 10 m at 6 GHz

```

1 //Ex:82
2 clc;
3 clear;
4 close;
5 d=10; //in m
6 f=6*10^9; //in Hz
7 u=0.8; //Aperture efficiency
8 A=(%pi*d^2)/4;
9 c=3*10^8; //velocity of light in m/s

```

```

10 y=c/f; //wavelength in m
11 G=(u*4*3.14*A)/(y^2);
12 printf("Gain=%f db",10*log(G)/log(10));

```

Scilab code Exa 29.83 Determine the width in degree in the elevation direction

```

1 //Ex:83
2 clc;
3 clear;
4 close;
5 dx=1*(%pi/180); //azimuth beamwidth in rad
6 G=315507;
7 dy=(4*%pi*180)/(G*dx*%pi); //the width in degree
8 printf("The width=%f degree",dy);

```

Scilab code Exa 29.84 Determine the antenna power gain in db and also the operational frequency

```

1 //Ex:84
2 clc;
3 clear;
4 close;
5 x=3*10^(-4); //solid angle of antenna beam in sterad
6 G=(4*%pi)/x; //Power gain
7 g=10*log(G)/log(10); // power gain in db
8 u=0.90; //aperture efficiency
9 A=20; //crasection area
10 y=sqrt((u*4*%pi*%pi*A*A)/(4*G)); //operational
    wavelength in m
11 c=3*10^8; //velocity of light in m/s
12 f=c/y; //operational frequency in Hz
13 printf("The antenna power gain=%f db",g);

```

```
14 printf("\n The operational frequency=%f MHz" ,f
    /1000000);
```

Scilab code Exa 29.85 Determine the antenna power gain

```
1 //Ex:85
2 clc;
3 clear;
4 close;
5 d=20; //dia in m
6 A=(%pi*d*d)/4; // Aperture area
7 c=3*10^8; //velocity of light in m/s
8 f1=11.95*10^9; //in Hz
9 f2=14.25*10^9; // in Hz
10 y1=c/f1; //wavelength in m for f1
11 y2=c/f2; //wavelength in m for f2
12 u1=0.98*0.99*0.97*0.85*0.90*0.92; //aperture eff for
    11.95 GHz
13 u2=0.96*0.99*0.97*0.85*0.90*0.92; //aperture eff for
    14.25 GHz
14 G1=(u1*4*%pi*A)/(y1*y1);
15 G2=(u2*4*%pi*A)/(y2*y2);
16 g2=10*log(G2)/log(10); // in db
17 g1=10*log(G1)/log(10); // in db
18 printf("The antenna power gain=%f db",g1);
19 printf("\n The antenna power gain=%f db",g2);
```

Scilab code Exa 29.86 Determine the earth station EIRP

```
1 //Ex:86
2 clc;
3 clear;
4 close;
```

```

5 p_o=10*log(10000)/log(10); // power at output in dbW
6 g_a=60; // antenna gain in dbW
7 l_s=2; // losses in dbw
8 e_irp=p_o+g_a-l_s; // EIRP in dbw
9 printf("The earth station EIRP=%d dbW",e_irp);

```

Scilab code Exa 29.87 Determine the equivalent noise temp of the cascaded arrangement

```

1 //Ex:87
2 clc;
3 clear;
4 close;
5 t_e1=100; // in K
6 t_e2=60; // in K
7 t_e3=20; // in K
8 G1=10^6;
9 G2=10^4;
10 t_e=t_e1+(t_e2/G1)+(t_e3/G1*G2);
11 printf("The equivalent noise temperature=%d K",t_e);

```

Scilab code Exa 29.88 Determine the noise figure of the cascaded arrangement

```

1 //Ex:88
2 clc;
3 clear;
4 close;
5 F1=2;
6 F2=10;
7 F3=15;
8 F4=20;
9 G1=100;

```

```

10 G2=10;
11 G3=10;
12 F=F1+(F2-1)/G1+(F3-1)/(G1*G2)+(F4-1)/(G1*G2*G3);
13 f=10*log(F)/log(10); //noise figure in db
14 printf("The noise figure=%f db",f);

```

Scilab code Exa 29.89 Determine the earth station system noise temp and GT ratio referred to the input of the low noise amplifier

```

1 //Ex:89
2 clc;
3 clear;
4 close;
5 t_a=60; // antenna noise temp in k
6 l1=1.075; //loss in waveguide in K
7 t_o=290; // in K
8 t_e2=160; // in K;
9 t_e3=10000; // in k
10 G2=10^6; // low noise ampr gain
11 t_s=(t_a/l1)+(l1-1)*(t_o)/l1; // noise temp in k
12 t_e=t_e2+(t_e3/G2); // Equivalent noise temp in K
13 t=t_s+t_e; // system noise temp in k
14 T=10*log(t)/log(10); //system noise temp in db
15 G=66-0.3; // in db
16 g_t=G-T; //G/T ratio in db/K
17 printf("The system noise temperature=%f K", t);
18 printf("\n The G/T ratio=%f db/K", g_t);

```

Scilab code Exa 29.90 Determine the earth station system noise temp and GT ratio referred to the input of waveguide and input of down converter

```

1 //Ex:90

```

```

2  clc;
3  clear;
4  close;
5  t_a=60; // antenna noise temp in k
6  l1=1.075; //loss in waveguide in K
7  t_o=290; // in K
8  t_e2=160; // in K;
9  t_e3=10000; // in k
10 G2=10^6; // low noise ampr gain
11 t_eq=(l1-1)*t_o+(t_e2*l1)+(t_e3*l1)/G2; // in K
12 t_s1=t_a+t_eq; // in k
13 T_s1=10*log(t_s1)/log(10); // in db
14 G=66; // in db
15 g_t1=G-T_s1; //G/T ratio in db/K
16 t_s2=(t_a*G2)/l1+(l1-1)*(t_o*G2)/l1+(t_e2*G2)+t_e3;
17 T_s2=10*log(t_s2)/log(10); // in db
18 G_2=66-0.3+60; // in db
19 g_t2=G_2-T_s2; //G/T ratio in db/K
20 printf("The G/T ratio=%f db/K", g_t1);
21 printf("\n The G/T ratio=%f db/K", g_t2);
22 printf("\n Both the G/T ratio are same");

```

Scilab code Exa 29.91 Determine the first local oscillator frequency range of second oscillator frequency and frequency spectrum

```

1  //Ex:91
2  clc;
3  clear;
4  close;
5  b_c=36; //carrier BW in MHz
6  f_c=1000; //Center freq in MHz
7  f_i=70; // first intermediate freq in MHz
8  f_smx=6400; //max uplink freq spectrum in MHz
9  f_smn=5900; //min uplink freq spectrum in MHz
10 f_l1=f_c-f_i; // in MHz

```



```

11 f_l2mx=f_smx-f_c; // in MHz
12 f_l2mn=f_smn-f_c; // in MHz
13 f_s1=f_smx-2*(f_l1+f_i);
14 f_s2=f_smn-2*(f_l1+f_i);
15 printf("The first local oscillator frequency=%f MHz"
    , f_l1);
16 printf("\n The max second oscillator frequency =%f
    GHz", f_l2mx/1000);
17 printf("\n The min second oscillator frequency =%f
    GHz", f_l2mn/1000);
18 printf("\n The max frequency spectrum =%f GHz", f_s1
    /1000);
19 printf("\n The min frequency spectrum =%f GHz", f_s2
    /1000);

```

Scilab code Exa 29.92 Determine the first local oscillator frequency and range of second oscillator frequency and frequency spectrum and BW of BPF1 and BPF2

```

1 //Ex:92
2 clc;
3 clear;
4 close;
5 b_c=72; //carrier BW in MHz
6 f_c=1190; //Center freq in MHz
7 f_i=140; // first intermediate freq in MHz
8 f_smx=14500; //max uplink freq spectrum in MHz
9 f_smn=14000; //min uplink freq spectrum in MHz
10 f_l1=f_c-f_i; // in MHz;
11 f_l1=f_c-f_i; // in MHz
12 f_l2mx=f_smx-f_c; // in MHz
13 f_l2mn=f_smn-f_c; // in MHz
14 f_s1=f_smx-2*(f_l1+f_i);
15 f_s2=f_smn-2*(f_l1+f_i);
16 b_pf1=140; // in MHz

```

```

17 b_pf2=500; // in MHz
18 printf("The first local oscillator frequency=%f MHz"
    , f_l1);
19 printf("\n The max second oscillator frequency =%f
    GHz", f_l2mx/1000);
20 printf("\n The min second oscillator frequency =%f
    GHz", f_l2mn/1000);
21 printf("\n The max frequency spectrum =%f GHz", f_s1
    /1000);
22 printf("\n The min frequency spectrum =%f GHz", f_s2
    /1000);
23 printf("\n The BW of BPF-1=%f MHz", b_pf1);
24 printf("\n The BW of BPF-1=%f MHz", b_pf2);

```

Scilab code Exa 29.93 Determine the first local oscillator frequency range of second oscillator frequency and frequency spectrum

```

1 //Ex:93
2 clc;
3 clear;
4 close;
5 b_c=36; //carrier BW in MHz
6 f_d=4000; //Down link freq in MHz
7 f_i=70; // first intermediate freq in MHz
8 f_smx=4200; //max uplink freq spectrum in MHz
9 f_smn=3700; //min uplink freq spectrum in MHz
10 f_d12=1000; // in MHz
11 f_l2=f_d-f_d12; // in MHz
12 f_l1=f_d-f_i-f_l2; // in MHz
13 printf("The max second oscillator frequency =%f GHz"
    , f_l2/1000);
14 printf("\n The min second oscillator frequency =%f
    MHz", f_l1);
15 printf("\n The center frequency of BPF-1 =%f GHz",
    f_d12/1000);

```

```
16 printf("\n The BW=%f MHz", b_c);
```

Scilab code Exa 29.94 Determine the center frequency BW of BPF1 and range of second oscillator frequency

```
1 //Ex:94
2 clc;
3 clear;
4 close;
5 b_c=72; //carrier BW in MHz
6 f_l1=2100; //first local oscillator frequency in MHz
7 f_i=140; // first intermediate freq in MHz
8 f_smx=11700; //max downlink freq spectrum in MHz
9 f_smn=10700; //min downlink freq spectrum in MHz
10 f_c=f_l1+f_i; //in MHz
11 f_l2mx=f_smx-f_c; // in MHz
12 f_l2mn=f_smn-f_c; // in MHz
13 printf("The center frequency of BPF_1=%f GHz", f_c
    /1000);
14 printf("\n The BW=%f MHz", f_i);
15 printf("\n The max second oscillator frequency =%f
    GHz", f_l2mx/1000);
16 printf("\n The min second oscillator frequency =%f
    GHz", f_l2mn/1000);
```

Scilab code Exa 29.95 Find the system noise temperature and GT as referred to the input of low noise amplifier

```
1 //Ex:95
2 clc;
3 clear;
4 close;
5 g_a=55; // antenna gain in db
```

```

6 l_w=0.1; //waveguide loss in db
7 L=10^(0.01); //waveguide loss
8 t_o=300; // in k
9 t_a=25+3.3+1+10+15; //antenna noise temperature in k
10 t_e=(L-1)*t_o; //equivalent noise temp in k
11 t_s=t_a+(L-1)*t_o/L; // in k
12 g_ln=10^(55/10);
13 t_eq=45+(315000/g_ln); // in K
14 t=t_s+t_eq; // in K
15 G=g_a-l_w; // in db
16 g_t=G-10*log(t)/log(10); // in db/K
17 printf("The system noise temperature =%d k", t);
18 printf("\n The G/T ratio=%f db/K", g_t);

```

Scilab code Exa 29.96 Determine the equivalent noise temperature of the low noise amplifier

```

1 //Ex:96
2 clc;
3 clear;
4 close;
5 t_o=300; // in K
6 g_a=65; // antenna gain in db
7 n_c=60; //in K
8 l_w=0.5; //waveguide loss in db
9 g_s=g_a-l_w; //system gain in db
10 L=10^(.5/10);
11 t_s=(n_c/L)+(L-1)*t_o/L;
12 g_t=40; // in db/K
13 t=10^((g_s-g_t)/10); //in k
14 t_e=t-t_s; //in k
15 printf("The equivalent noise temperature=%f K", t_e)
    ;

```

Scilab code Exa 29.97 Determine the output powers of the three carriers

```
1 //Ex:97
2 clc;
3 clear;
4 close;
5 p_i1=50; // i/p power at f1 in db
6 p_i2=40; // i/p power at f2 in db
7 p_i3=25; // i/p power at f2 in db
8 p_c1=47; // carrier power at (f1) at i/p of second 3
   db coupler
9 p_c2=37; // carrier power at (f2) at i/p of second 3
   db coupler
10 p_c3=25; // carrier power at (f3) at i/p of second 3
   db coupler
11 pc1=p_c1-3; // carrier power at (f1) at output in db
12 pc2=p_c2-3; // carrier power at (f2) at output in db
13 pc3=p_c3-3; // carrier power at (f3) at output in db
14 printf("The carrier power at (f1) at output=%f db",
   pc1);
15 printf("\n The carrier power at (f2) at output=%f db
   ", pc2);
16 printf("\n The carrier power at (f3) at output=%f db
   ", pc3);
```

Scilab code Exa 29.98 Determine the power loss suffered by each one of the five carriers after all have combined and appeared at the output

```
1 //Ex:98
2 clc;
3 clear;
4 close;
```

```

5 f_d1=3; // in db
6 A=10^(-f_d1/10);
7 B=1-A;
8 l_s=-10*log(B)/log(10);
9 f_d2=4.76; // in db
10 A2=10^(-f_d2/10);
11 B2=1-A2;
12 l_s2=-10*log(B2)/log(10);
13 f_d3=6; // in db
14 A3=10^(-f_d3/10);
15 B3=1-A3;
16 l_s3=-10*log(B3)/log(10);
17 f_d4=6.97; // in db
18 A4=10^(-f_d4/10);
19 B4=1-A4;
20 l_s4=-10*log(B4)/log(10);
21 l_o=f_d3+l_s4; //in db
22 printf("The power loss suffered of the five carriers
        after all have combined=%f db",l_o);

```

Scilab code Exa 29.99 Find the link carrier to noise ratio

```

1 //Ex:99
2 clc;
3 clear;
4 close;
5 c_nu=10^(25/10); // The uplink carrier to noise ratio
6 c_nd=10^(20/10); // The uplink carrier to noise ratio
7 c_n1=(1/c_nu)+(1/c_nd);
8 c_n=1/c_n1; // carrier to noise ratio
9 printf("The carrier to noise ratio=%f db", 10*log(
        c_n)/log(10));

```

Scilab code Exa 29.100 determine CNu and CNd and CN

```
1 //Ex:100
2 clc;
3 clear;
4 close;
5 p_c=10*log(200)/log(10); // carrier power in db
6 g_t=57.6; // transmit gain in db
7 B_oi=0; // in db
8 e_s=p_c+g_t+B_oi; //satellite saturation EIRP in dbW
9 k=10*(log(1.38)/log(10)-23*log(10)/log(10)); //
    Boltzmann's const in db
10 B=10*log(36000000)/log(10); // in db
11 L=1.5; // in db
12 s=20*log((4*3.14*14*(10^9)*37000*(10^3))/(3*(10^8)))
    /log(10);
13 g_t=1.6; // in db
14 c_nu=e_s-s+g_t-k-B-B_oi-L;
15 G=56.3; // in db
16 g_td=G-10*log(160)/log(10);
17 L1=1; // in db
18 e_s1=44; // in db
19 s1=20*log((4*3.14*12*(10^9)*37000*(10^3))/(3*(10^8)))
    )/log(10);
20 c_nd=e_s1-s1+g_td-k-B-B_oi-L1;
21 c_u=10^(27/10);
22 c_d=10^(24.9/10);
23 c_n=(c_u*c_d)/(c_u+c_d);
24 printf("The uplink carrier to noise ratio=%f db",
    c_nu);
25 printf("\n The downlink carrier to noise ratio=%f db
    ", c_nd);
26 printf("\n The carrier to noise ratio=%f db", 10*log
    (c_n)/log(10));
```

Scilab code Exa 29.101 Determine the carrier EIRP required to saturate the satellite TWTA

```
1 //Ex:101
2 clc;
3 clear;
4 close;
5 p_t=10*log(500)/log(10); // in dbW
6 g_t=60; // in dbW
7 e_irp=p_t+g_t;
8 e_p=ceil(e_irp);
9 B_oi=1; // input back_off in db
10 e_s=e_p+B_oi; //saturation EIRP in dbW
11 printf("The saturation EIRP=%d dbW", e_s);
```

Scilab code Exa 29.102 Determine the satellite EIRP for the retransmitted carrier

```
1 //Ex:102
2 clc;
3 clear;
4 close;
5 B_o=10*log(2)/log(10); // in db
6 b_o=floor(B_o);
7 e_ps=50; // in db
8 e_irps=e_ps-b_o; // satellite EIRP in db
9 printf("The satellite EIRP for the retransmitted
   carrier=%d dbW", e_irps);
```

Scilab code Exa 29.103 Determine the angular separation of the two satellites as viewed by the earth station also determine the separation distance between the two satellites in the orbit


```

1 //Ex:103
2 clc;
3 clear;
4 close;
5 b=85-25; // in degree
6 r=42164; //orbit radius in km
7 d_a=38000; // in km
8 d_b=36000; // in km
9 x=1-cos(b*3.14/180);
10 y=acos((d_a^2+d_b^2-2*r*r*x)/(2*d_a*d_b)) // in
    radian
11 z=y*180/3.14; // in degree
12 d=1.4149*r*sqrt(x);
13 printf("The angular separation of the two satellites
    =%f degree", z);
14 printf("\n The separation distance of the two
    satellites=%f km", d);

```

Scilab code Exa 29.104 Determine the angular separation and separation distance

```

1 //Ex:104
2 clc;
3 clear;
4 close;
5 b=30-25; // in degree
6 r=42164; //orbit radius in km
7 d_a=38000; // in km
8 d_b=36000; // in km
9 x=1-cos(b*3.14/180);
10 y=acos((d_a^2+d_b^2-2*r*r*x)/(2*d_a*d_b)) // in
    radian
11 z=y*180/3.14; // in degree
12 d=1.414*r*sqrt(1-0.996);
13 D=1.414*r*0.063;

```

```

14 printf("The angular separation of the two satellites
    =%f degree", z);
15 printf("\n The separation distance of the two
    satellites=%f km", D);

```

Scilab code Exa 29.105 Calculate the power flux density at the satellite for an earth station located at 90 degree W longitude and 40 degree N latitude

```

1 //Ex:105
2 clc;
3 clear;
4 close;
5 u=0.55; //efficiency
6 f=14*10^9; // in hz
7 D=5; // in m
8 c=3*10^8; // speed of light in m/s
9 g=(u*(%pi*f*D)^2)/(c*c); //antenna gain
10 G=10*log(g)/log(10); //antenna gain in db
11 p_amp=26.98; // in db
12 b_o=3; // in db
13 p_op=p_amp-b_o; // in db
14 l_w=0.5; // in db
15 p_f=p_op-l_w; // in db
16 e_irp=p_op+G; // in db
17 e=23.48+54.7; // in db
18 e_p=10^(e/10);
19 R=42164; // in km
20 r=6378; // in km
21 E=41; // in degree
22 q=E+asin((r*(cos(E*3.14/180))/R)*180/3.14);
23 q1=47.55;
24 d=(R*R)+(r*r)-2*R*r*sin(q1*3.14/180);
25 d1=sqrt(d);
26 d_f=(e_p)/(4*%pi*d);
27 printf("Power flux density=%e W/sq.m", d_f/1000000);

```

Scilab code Exa 29.106 Determine the theoretical max area of the earth surface

```
1 //Ex:106
2 clc;
3 clear;
4 close;
5 R_e=6378; //in km
6 H=35786; // in km
7 l=R_e/(R_e+H);
8 m=asin(l); // in rad
9 a=m*180/3.14; // in degree
10 x=90-8.7; // in degree
11 o_c=R_e*sin(a*3.14/180); // dis OC in the given
    triangle AOC IN KM
12 h=R_e-o_c; //in km
13 E=10; // in degree
14 y=90-a-E; // in degree
15 O_C=R_e*sin(18.56*3.14/180);
16 O_C1=ceil(O_C); // the newvalue of OC in km
17 h1=R_e-O_C1; // The new value of H in km
18 a_r=2*3.14*R_e*h1; //in sq.km
19 printf("The covered area=%d sq.km", a_r);
```

Scilab code Exa 29.107 Determine the percentage of the earth area covered for the two cases of angle of elevation

```
1 //Ex:107
2 clc;
3 clear;
4 close;
```

```

5 R_e=6378; //in km
6 h1=5413.26; // in km when E=0 degree
7 h2=4348; // in km when E=10 degree
8 a_r1=h1*100/(2*R_e); // percentage of area covered
9 a_r2=h2*100/(2*R_e); //percentage of area covered
10 printf("The percentage of area covered when E=0
    degree=%f %%", a_r1);
11 printf("\n The percentage of area covered when E=0
    degree=%f %%", a_r2);

```

Scilab code Exa 29.108 Determine the gain of spot beam antenna if the glowal coverage antenna has a gain of 50 db

```

1 //Ex:108
2 clc;
3 clear;
4 close;
5 g_gc=10^(50/10);
6 a_c=4.5; // coverage angle in degree
7 a_b=17.34; // beam angle in degree
8 g_sb=g_gc*(a_b/a_c)^2;
9 printf("The gain of spot beam antenna=%f db", 10*log
    (g_sb)/log(10));

```
