

```
balltr.m x spectrum.m x Test2.m x Test3.m x addtitl.m x twoplts.m x Test6.m x eci2ecf2.m x crcle4.m x Main.m x linkbudget42.m x Main2.m x +
1 - clc;
2 - clear all;
3 - %coordinates of ground station bangalore
4 - deg2rad = pi/180;
5 - rad2deg = 180/pi;
6 - latd=13.03;
7 - lond=77.50;%in degrees
8 - H=0.838;%km
9 - re=6378;%km
10 - ae=6378.1414;
11 - latr=latd*deg2rad;
12 - lonr=lond*deg2rad;%in radians
13 - Start=2458317.67012; %Start time in julian date 17th july 2018 (04:05:00)UTC
14 - %t2=2458318.67012; %End time in julian date 18th july 2018 (04:05:00)UTC
15 - End=2458320.67012;
16 - JD=End; %End Time
17 - JDref=2415020;
18 - JC=36525; %Julian century from 1900
19 - Startfrac=0.17012; %Fractional part of day (17th july 2018), time at which TLE elements or keplerian elements were obtained
20
21 - %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
22 - duration=End-Start; %Enter for how much time simulation has to be run in days.
23 - days=duration+0.17012; %Enter no of days for simulation from epoch
24 - min=1440;
25 - sec=86400;
26 - %JD=linspace(t1,t2,1440); %updating minute by minute
27 - T=(JD-JDref)./JC;
28 - %UTday=0.041666.*(H+(m/60)+(S/3600));
29 - %UTdeg=UTday.*360;
30 - UT=linspace(0.17012,days,duration*min); %Fractional part of the day starting from 4:05:00 UTC
31 - UTD=UT.*360;
32 - UTD=mod(UTD,360);
33 - x=(36000.7689.*T);
34 - X=mod(x,360);
35 - y=0.0004.*(T.^2);
36 - Y=mod(y,360);
37 - gmst=99.6910+X+Y+UTD;
```

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37 - gmst=55.832161411016;
38 - gmst=mod(gmst,360);
39 - lmst=gmst+lond;
40 - lmst=mod(lmst,360);
41 - u=3.986005*10^14;
42
43 %IRS P6
44 - in=98.5525;%inclination
45 - ohm0=276.0870;%RAAN
46 - e0=0.00563;%eccentricity
47 - omega0=303.7850;%Argument of perigee
48 - v0=55.928;%True anamoly = Mean anamoly
49 - n0=14.34156; %Mean motion
50 - sat='IRS P6';
51
52 % % IRS P5
53 % in=97.873;
54 % ohm0=257.9920;
55 % e0=0.001044;
56 % omega0=51.2651;
57 % v0=308.8671;
58 % n0=14.787;
59 % sat='IRS P5';
60
61 % %CARTOSAT 2AT
62 % in=97.82;
63 % ohm0=218.5088;
64 % e0=0.002763;
65 % omega0=45.0401;
66 % v0=315.1040;
67 % n0=14.834760;
68 % sat='CARTOSAT 2AT';
69 %
70 % %CARTOSAT 2A
71 % in=97.8747;
72 % ohm0=258.1189;
73 % e0=0.014365;
74 % omega0=113.7127;
```

```
75 % v0=246.5598;  
76 % n0=14.7869;  
77 % sat='CARTOSAT 2A';  
78  
79 % %CARTOSAT 2B  
80 % in=97.4082;  
81 % ohm0=259.6822;  
82 % e0=0.014936;  
83 % omega0=183.8495;  
84 % v0=176.2627;  
85 % n0=14.7869;  
86 % sat='CARTOSAT 2B';  
87 %  
88 % % CARTOSAT 2C  
89 % in=97.4082;  
90 % ohm0=259.6822;  
91 % e0=0.0014936;  
92 % omega0=129.0233;  
93 % v0=288.5499;  
94 % n0=15.1924;  
95 % sat='CARTOSAT 2C';  
96 %  
97 % %CARTOSAT 2D  
98 % in=97.4428;  
99 % ohm0=260.1310;  
100 % e0=0.005160;  
101 % omega0=281.3608;  
102 % v0=78.7046;  
103 % n0=15.1925;  
104 % sat='CARTOSAT 2D';  
105  
106 % %CARTOSAT 2E  
107 % in=97.3975;  
108 % ohm0=256.9172;  
109 % e0=0.0080;  
110 % omega0=332.8002;  
111 % v0=27.2809;  
112 % n0=15.1925;
```

```

159
160
161 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
162 - nrad=2*pi*n0/86400;%Mean motion in rad/s
163 - ndd=nrad*86400*rad2deg;%Mean motion in deg/day
164 - v=v0+(ndd.*duration);%Total motion in terms of days
165
166 - vrot=linspace(v0,v,duration*min);%True anomaly for total duration updated minute by minute
167 - vrot=mod(vrot,360);%scaled to 360 deg format
168
169 - a=(u./(nrad.^2)).^0.333;%Semimajor axis a
170 - a=a/1000; %km
171 - rapogee=a.*(1+e0);%apogee
172 - rperigee=a.*(1-e0);%perigee
173 - ha=rapogee-re;%Apogee height
174 - hp=rperigee-re;%Perigee height
175 - kl=66063.17;%km^2
176
177 %for l=linspace((Startfrac*min),(duration*min),(duration*min))
178 - l=linspace((Startfrac*min),(duration*min),(duration*min)); %Calculating for number of days in minutes
179 - k=(ndd.*kl)./(a.^2).*(1-e0.^2); %deg/day
180 - dohmdt=cos(in.*deg2rad).*k.*(-1); %Rate of regression of nodes (Related to RAAN)
181 - ohm=ohm0+(dohmdt.*l);
182 - ohm=mod(ohm,360);
183
184 - domegadt=k.*(2-2.5.*(sin(in.*deg2rad).^2));%deg/day
185 - omega=omega0+(domegadt.*l);
186 - omega=mod(omega,360);
187 - omegar=omega.*deg2rad;
188 % scatter(l,ohm);
189 % grid on;
190 % hold on;
191 % xlim([0 5000]);
192 % ylim([0 370]);
193 % pause(0.01)
194 % end
195 - gmstr=gmst.*deg2rad;
196

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195 - gmstr=gmst.*deg2rad;
196
197 - r=(a.*(1-(e0.^2)))/(1+e0.*cos(v0));
198 - vrotr=vrot.*deg2rad;
199 - rp=r.*(cos(vrotr));
200 - rq=r.*(sin(vrotr));
201 - r1=(cos(ohm).*cos(omega));
202 - r2=(sin(ohm).*sin(omega).*cos(in));
203 - r3=(-1).*cos(ohm).*sin(omega);
204 - r4=(sin(ohm).*cos(omega).*cos(in));
205 - r5=(sin(ohm).*cos(omega));
206 - r6=cos(ohm).*sin(omega).*cos(in);
207 - r7=(-1).*sin(ohm).*sin(omega);
208 - r8=cos(ohm).*cos(omega).*sin(in);
209 - r9=(sin(omega).*sin(in));
210 - r10=(cos(omega).*sin(in));
211 - R12=r1-r2;
212 - R34=r3-r4;
213 - R56=r5+r6;
214 - R78=r7+r8;
215 - R9=r9;
216 - R10=r10;
217 % alpha=(atan(cos(in).*tan(omegar+vrotr)).*rad2deg)+ohm;
218 % alpha=mod(alpha,360);
219 % delta=(asin(sin(in).*sin(omegar+vrotr)).*rad2deg);
220 % delta=mod(delta,360);
221 % lons=alpha-gmst;
222 % lons=mod(lons,360);
223
224
225 - R=[R12;R56;R9;R34;R78;R10];
226 - Rm=[R12 R34;R56 R78;R9 R10];%R'
227 - Rd=[rp;rq];%|rp|
228         %|rq|
229 % rI=(R12.*rp)+(R34.*rq);
230 % rJ=(R56.*rp)+(R78.*rq);
231 % rK=(R9.*rp)+(R10.*rq);
232 % S=(rI.^2)+(rJ.^2)+(rK.^2);

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```

231 % rK=(R9.*rp)+(R10.*rq);
232 % S=(rI.^2)+(rJ.^2)+(rK.^2);
233 % rv=sqrt(S);
234 - for i=1:1:duration*min
235 -     R2=R(1:3,i)*rp;%r1 r3 r5
236 -     R3=R(4:6,i)*rq;%r2 r4 r6
237 -     rI=R2(1,1:i)+R3(1,1:i);%rI
238 -     rJ=R2(2,1:i)+R3(2,1:i);%rJ
239 -     rK=R2(3,1:i)+R3(3,1:i);%rK
240 -     rIJK=[rI;rJ;rK];
241 % S=((rI(1,1:i)).^2)+(rJ(1,1:i)).^2)+(rK(1,1:i)).^2);
242 % rv=sqrt(S);
243 - end
244 - xd=((rI.*cos(gmstr))+(rJ.*sin(gmstr)));
245 - yd=((-1).*rI.*sin(gmstr))+rJ.*cos(gmstr));
246 - zd=rK;
247 - lons=atan(yd./xd);
248 - lats=atan(zd./sqrt((xd.^2)+(yd.^2)));
249 - lons=(lons.*rad2deg);
250 - lats=(lats.*rad2deg);
251 - S=(rI.^2)+(rJ.^2)+(rK.^2);
252 - rv=sqrt(S);
253 - Ee=0.08182;%Eccentricity of the earth
254 - nl=1-((Ee.^2).*(sin(lonr).^2));
255 - N=ae./sqrt(nl);
256 - L=(N+H).*cos(lonr);
257 - lmstr=lmst.*deg2rad;
258 - RI=L.*cosd(lmstr);
259 - RJ=L.*sind(lmstr);
260 - RK=(N.*(1-(Ee.^2))+H).*sind(lonr);%Z
261 - rooI=rI-RI;
262 - rooJ=rJ-RJ;
263 - rooK=rK-RK;
264 - siE=atan(RK./L);
265 - siED=siE.*rad2deg;
266 - w=siE;
267 - s11=sin(w).*cos(lmstr);
268 - s12=sin(w).*sin(lmstr);

```

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267 - s11=sin(w).*cos(lmstr);
268 - s12=sin(w).*sin(lmstr);
269 - s13=(-1).*cos(w);
270 - s21=(-1).*sin(lmstr);
271 - s22=cos(lmstr);
272 - s23=0;
273 - s31=cos(w).*cos(lmstr);
274 - s32=cos(w).*sin(lmstr);
275 - s33=sin(w);
276 - S13=(1:(duration*min));
277 - S23=(1:(duration*min));
278 - S33=(1:(duration*min));
279 - for i=1:1:(duration*min)
280 -     S13(i)=s13;
281 -     S23(i)=s23;
282 -     S33(i)=s33;
283 - end
284 - %rooSEZ=[s11 s12 S13;s21 s22 S23;s31 s32 S33];
285 - roosez=[s11;s21;s31;s12;s22;s32;S13;S23;S33];
286 - for i=1:1:duration*min
287 -     rooA=roosez(1:3,i)*rooI;
288 -     rooB=roosez(4:6,i)*rooJ;
289 -     rooC=roosez(7:9,i)*rooK;
290 -     % rooS=rooA(1,1:i)+rooB(1,1:i)+rooC(1,1:i);
291 -     % rooE=rooA(2,1:i)+rooB(2,1:i)+rooC(2,1:i);
292 -     % rooZ=rooA(3,1:i)+rooB(3,1:i)+rooC(3,1:i);
293 -
294 -     % roo=sqrt(de);
295 -     % des=(rooZ./roo);
296 -     rooS=(s11.*rooI)+(s12.*rooJ)+(S13.*rooK);
297 -     rooE=(s21.*rooI)+(s22.*rooJ)+(S23.*rooK);
298 -     rooZ=(s31.*rooI)+(s32.*rooJ)+(S33.*rooK);
299 -     de=(rooS(1,1:i).^2)+(rooE(1,1:i).^2)+(rooZ(1,1:i).^2);
300 -     % de=(rooA(1,1:i).^2)+(rooB(1,1:i).^2)+(rooC(1,1:i).^2);
301 -     rooSEZ=[rooS;rooE;rooZ];
302 -     % de=(rooS.^2)+(rooE.^2)+(rooZ.^2);
303 -     % roo=sqrt(de);
304 -     % des=(rooZ./roo);
```

```
balltr.m x spectrum.m x Test2.m x Test3.m x addtitl.m x twoplts.m x Test6.m x eci2ecf2.m x crcle4.m x Main.m x linkbudget42.m x Main2.m x +
306 % rooS=(s11.*rooI)+(s12.*rooJ)+(s13.*rooK);
307 % rooE=(s21.*rooI)+(s22.*rooJ)+(s23.*rooK);
308 % rooZ=(s31.*rooI)+(s32.*rooJ)+(s33.*rooK);
309 % rooSEZ=[rooS;rooE;rooZ];
310 % % de=(rooS.^2)+(rooE.^2)+(rooZ.^2);
311 % % roo=sqrt(de);
312 % % des=(rooZ./roo);
313 % de=(rooS.^2)+(rooE.^2)+(rooZ.^2);
314 % roo=sqrt(de);
315 % des=(rooZ./roo);
316 % Elevation=asind(des);
317 %Elevation=Elevation.*rad2deg;
318 %Elevation=(Elevation);
319 %Elevation=mod(Elevation,180);
320 - rooS=(1:duration*min);
321 - rooE=(1:duration*min);
322 - for i=1:1:duration*min
323     rooS(i)=rooS(i);
324     rooE(i)=rooE(i);
325     % if(rooE(i)<0)
326     %     rooE(i)=rooE(i).*(-1);
327     %
328     % end
329     % end
330     % for i=1:1:duration*min
331     % if(rooS(i)<0)
332     %     rooS(i)=rooS(i).*(-1);
333     % end
334 - end
335 - Azimuth=atand(abs(rooE)./abs(rooS));
336 %Azimuth=mod(Azimuth,360);
337 % %Azimuth=Azimuth.*rad2deg;
338 - azi=Azimuth;
339 %Azimuth=mod(Azimuth,360);
340 - roo=sqrt(de);
341 - des=((rooZ)./(roo));
342 - Elevation=asind(des);
343
```



```
343
344 - for i=1:1:duration*min
345 -     if ((roos(i)>0)&&(rooe(i)>0))
346 -         Azimuth(i)=180-Azimuth(i);
347 -         %Azimuth(i)=mod(180-Azimuth,360);
348 -     end
349 -     if ((roos(i)>0)&&(rooe(i)<0))
350 -         Azimuth(i)=Azimuth(i)+180;
351 -         %Azimuth=mod(Azimuth,360);
352 -     end
353 -     if ((roos(i)<0)&&(rooe(i)<0))
354 -         Azimuth(i)=360-Azimuth(i);
355 -         %Azimuth=mod(360-Azimuth,360);
356 -     end
357 - end
358 - figure('NumberTitle','off','Name',sat);
359 - subplot(4,1,1);
360 - plot(1,Azimuth);
361 - grid on;
362 - xlabel('Time in minutes');
363 - ylabel('Azimuth in degrees');
364 - subplot(4,1,2);
365 - plot(1,Elevation);
366 - grid on;
367 - xlabel('Time in minutes');
368 - ylabel('Elevation in degrees');
369 - subplot(4,1,3);
370 - plot(1,lats);
371 - grid on;
372 - xlabel('Time in minutes');
373 - ylabel('Latitude');
374 - subplot(4,1,4);
375 - plot(1,lons);
376 - grid on;
377 - xlabel('Time in minutes');
378 - ylabel('Longitude');
379
```

IRS P6

```
1 28051U 03046A 18199.17012542 -.00000023 00000-0 76858-5 0 9994
2 28051 98.5525 276.0870 0056831 303.7850 55.7928 14.34156773766018
```

CARTOSAT-1 (IRS P5)

```
1 28649U 05017A 18199.16117770 .00000084 00000-0 16599-4 0 9996
2 28649 97.8218 271.3703 0001871 148.3680 211.7671 14.83476051714686
```

CARTOSAT 2AT

```
1 29710U 07001B 18199.18360229 -.00000129 00000-0 -10719-4 0 9992
2 29710 97.8733 257.9920 0001044 51.2651 308.8671 14.78714543621715
```

CARTOSAT 2A

```
1 32783U 08021A 18199.16133920 .00000125 00000-0 23941-4 0 9998
2 32783 97.8747 258.1189 0014365 113.7127 246.5598 14.78698447551651
```

CARTOSAT 2B

```
1 36795U 10035A 18199.19809141 .00000053 00000-0 14227-4 0 9998
2 36795 97.8725 257.8589 0014378 183.8495 176.2627 14.78698878432708
```

CARTOSAT 2C

```
1 41599U 16040A 18199.17104508 .00000403 00000-0 22284-4 0 9992
2 41599 97.4082 259.6822 0014936 129.0233 288.5449 15.19248425114778
```

CARTOSAT 2D

```
1 41948U 17008A 18198.86589900 +.00000363 +00000-0 +20454-4 0 9995
2 41948 097.4428 260.1310 0005160 281.3608 078.7046 15.19252302078596
```

CARTOSAT 2E

```
1 42767U 17036C 18198.87379413 +.00000363 +00000-0 +20401-4 0 9995
2 42767 097.3975 256.9172 0008080 332.8002 027.2809 15.19241156059168
```

OCEANSAT 2

```
1 35931U 09051A 18199.23755978 .00000076 00000-0 30419-4 0 9994
2 35931 98.3062 293.7925 0003537 67.0117 293.1451 14.50848789466889
```

RESOURCESAT 2A

```
1 41877U 16074A 18199.16276453 .00000002 00000-0 20571-4 0 9998
2 41877 98.6703 273.5977 0000619 109.6629 250.4627 14.21654907 83546
```

RISAT 1

```
1 38248U 12017A 18199.06791515 .00000196 00000-0 16147-4 0 9997
2 38248 97.5702 206.8083 0005542 115.9290 293.4380 15.09559923342957
```

SARAL

```
1 39086U 13009A 18198.92663080 -.00000012 +00000-0 +11750-4 0 9992
2 39086 098.5409 025.3311 0001845 124.3523 235.7835 14.32018797281743
```

GEOSYNCHRONOUS SATELLITES:

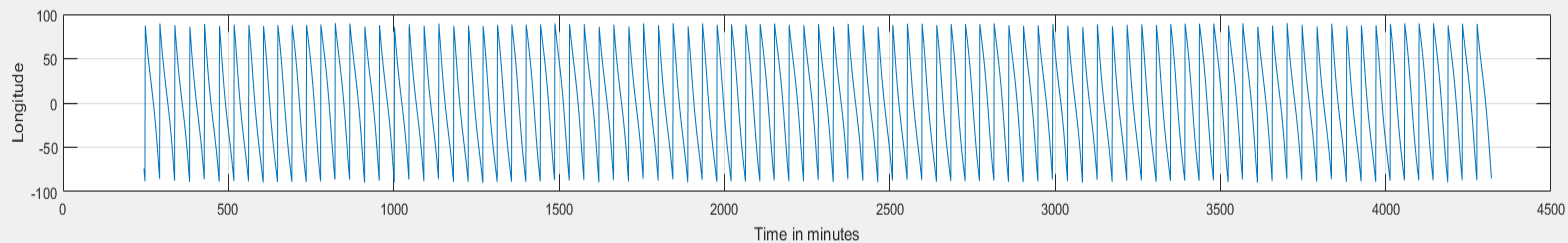
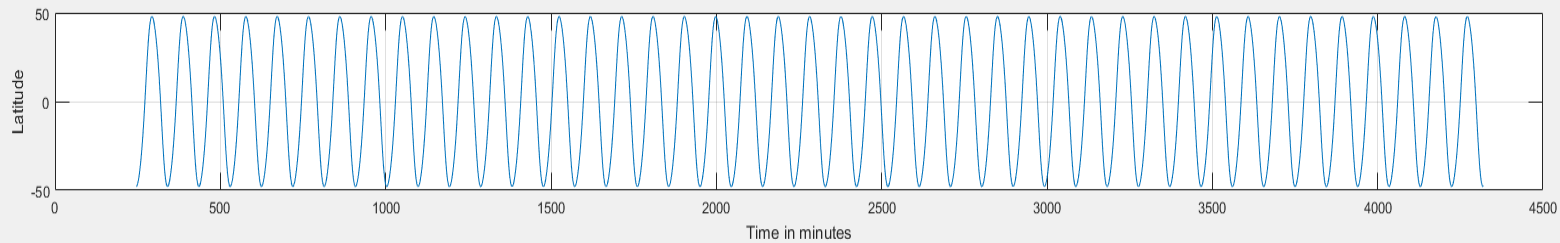
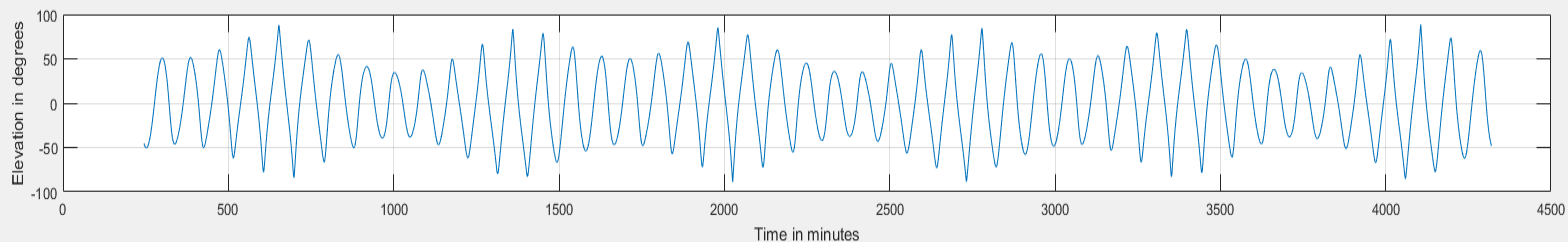
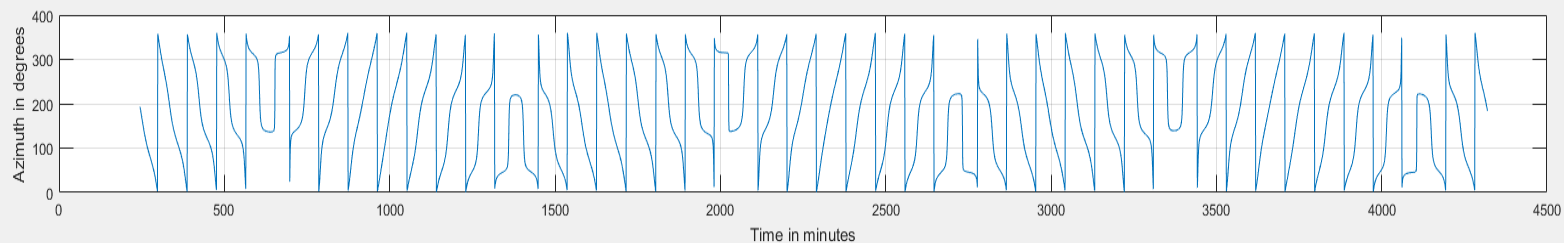
IRNSS R1A

```
1 39199U 13034A 18197.33087615 .00000068 00000-0 00000+0 0 9994
2 39199 29.4959 108.3047 0017870 178.4468 181.5322 1.00269647 18630
```

3 day plot for IRS P6

IRS P6

File Edit View Insert Tools Desktop Window Help





IRS P6



File Edit View Insert Tools Desktop Window Help

