Assignment 4

Group F

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1.

```
clc
clear
% vernaleqinox
alpha = 0; delta = 0;
vernaleqinox = [delta,alpha,1];
xi0 = latlonr2xyz(vernaleqinox)  %(rad,rad,m)-->(m,m,m)
```

```
xi0 = 1×3
     1     0     0
```

```
% JD in 1990-2030
yyyy = 1990:2030;
mm=1; dd=1; ut1=12; minute=0; second=0;
jd = gre2jd(yyyy,mm,dd,ut1,minute,second);
jd = jd(1:41) % Extract only Julian Date
```

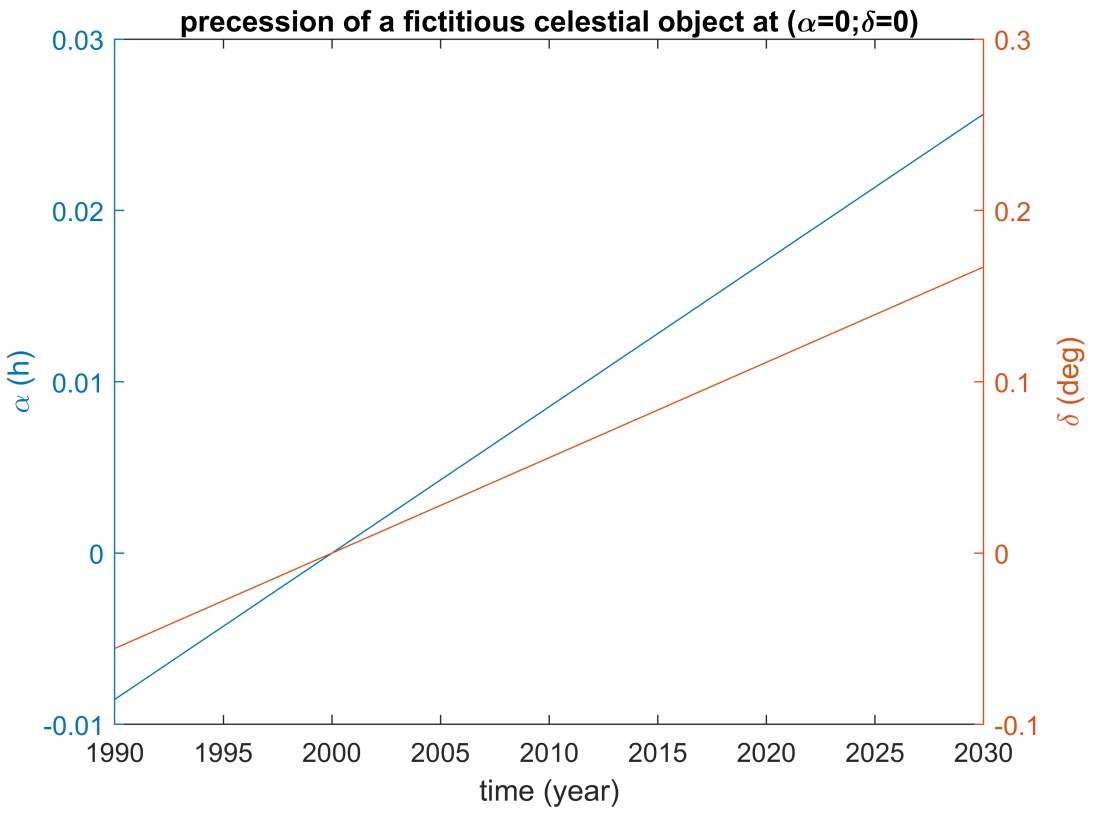
```
jd = 1×41
     2447893     2448258     2448623     2448989     2449354     2449719 ···
```

```
% P(JD)
%xip =
for i = 1:length(jd)
    Pjd = prec(jd(i));
    xip = Pjd * xi0';
    % (m,m,m) --> (rad,rad,m)
    sph_ip = xyz2latlonr(xip);
    % [delta,alpha,1] - [rad,rad,m]

    delta2(i) = sph_ip(1)*180/pi; % degree
    alpha2(i) = sph_ip(2)*12/pi; % hour angle
end
delta2,alpha2,yyyy
```

```
delta2 = 1×41
   -0.0557   -0.0501   -0.0445   -0.0390   -0.0334   -0.0278   -0.0223   -0.0167 ···
alpha2 = 1×41
   -0.0085   -0.0077   -0.0068   -0.0060   -0.0051   -0.0043   -0.0034   -0.0026 ···
yyyy = 1×41
        1990        1991        1992        1993        1994        1995 ···
```

```
fig1 = plotyy(yyyy,alpha2,yyyy,delta2);
title('precession of a fictitious celestial object at (\alpha=0;\delta=0)')
xlabel('time (year)')
```

```
ylabel(fig1(1),'\alpha (h)')
ylabel(fig1(2),'\delta (deg)')
```



2.

```
clc
clear
% vernaleqinox
alpha = 0; delta = 0;
vernaleqinox = [delta,alpha,1];
xi0 = latlonr2xyz(vernaleqinox)  %(rad,rad,m)-->(m,m,m)
```

```
xi0 = 1×3
     1     0     0
```

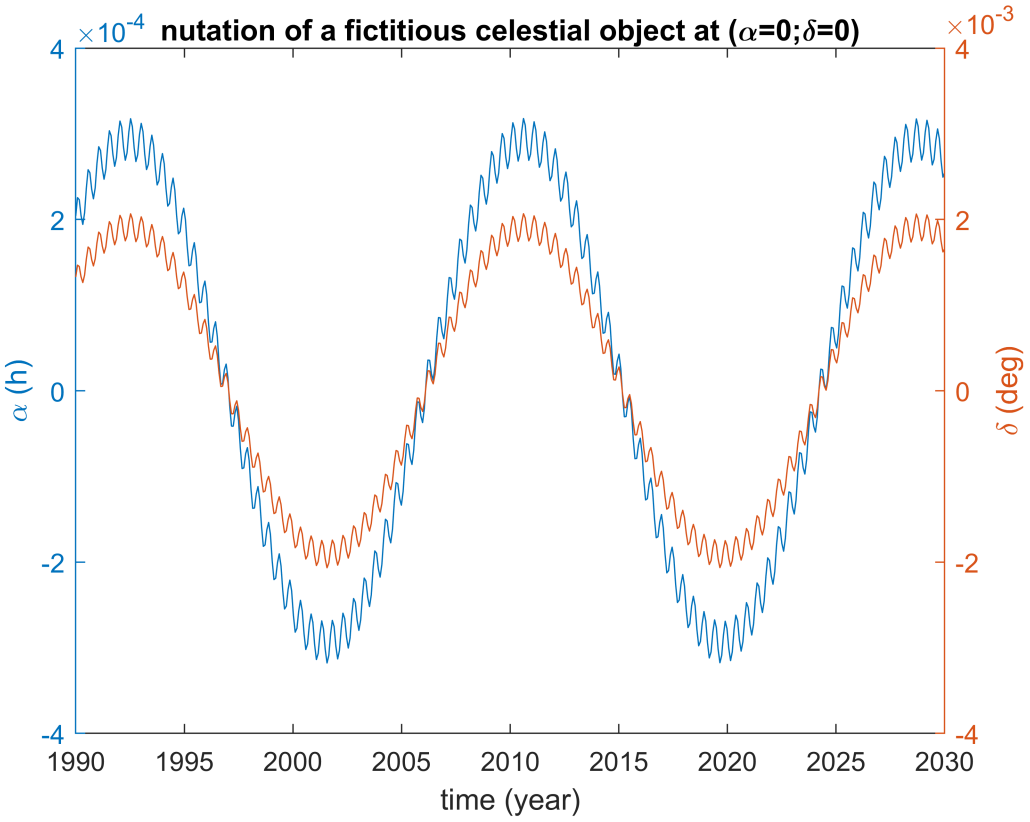
```
% JD in 1990-2030 with monthly resolution
mm=1:12;
dd=1; ut1=12; minute=0; second=0;
i = 1;
for yyyy = 1990:2030
    % Seperated Each Specific Year
    jd = gre2jd(yyyy,mm,dd,ut1,minute,second);
    % JD of 12 month in Specific year
    jd = jd(1:12); % Extract only Julian Date
    jd_all(i:i+11) = jd; %Insert Each Year of JD value in 12 months
    i = i +12;
end
jd_all % All JD in 1990-2030 with monthly resolution
```

```
jd_all = 1×492
     2447893      2447924      2447952      2447983      2448013      2448044 ···
```

```
%N(JD)
%xin =
for j = 1:length(jd_all)
    Njd = nut(jd_all(j));
    xin = Njd * xi0';
    % (m,m,m) --> (rad,rad,m)
    sph_in = xyz2latlonr(xin);
    % [delta,alpha,1] - [rad,rad,m]

    delta2(j) = sph_in(1)*180/pi; % degree
    alpha2(j) = sph_in(2)*12/pi; % hour angle
end
delta2,alpha2
```

```
delta2 = 1×492
    0.0013    0.0015    0.0015    0.0013    0.0013    0.0014    0.0015    0.0017 ···
alpha2 = 1×492
10^-3 ×
    0.2041    0.2255    0.2230    0.2045    0.1942    0.2077    0.2366    0.2581 ···
```

```
xaxis = linspace(1990,2030,492);
fig1 = plotyy(xaxis,alpha2,xaxis,delta2);
title('nutation of a fictitious celestial object at (\alpha=0;\delta=0)')
xlabel('time (year)')
ylabel(fig1(1),'\alpha (h)')
ylabel(fig1(2),'\delta (deg)')
```



3.

```
clc
clear

clc
clear
% vernaleqinox
alpha = 0; delta = 0;
vernaleqinox = [delta,alpha,1];
xi0 = latlonr2xyz(vernaleqinox);  %(rad,rad,m)-->(m,m,m)

[year,month,day,mjd,xpol,ypol,dUT1,LOD,dX,dY...
s_xpol,s_ypol,s_dUT1,s_LOD,s_dX,s_dy] = textread('IAU1980_body2021.txt');

% Xpol,Ypol between 2021-06-11 & 2021-06-12
%Row 162 - 2021-06-11
%Row 163 - 2021-06-12
xpol_inter = interp1(xpol(162:163),1:(1/24):2),...
ypol_inter = interp1(ypol(162:163),1:(1/24):2)
```

```
xpol_inter = 1×25
    0.1742    0.1743    0.1743    0.1744    0.1744    0.1745    0.1745    0.1746 ···
ypol_inter = 1×25
    0.4357    0.4357    0.4357    0.4357    0.4357    0.4357    0.4356    0.4356 ···
```

- Inter polation of Xp,Yp [sec. deg.] (hourly between 2021-06-11 & 2021-06-12)

```
%W(Xp,Yp)
for i = 1:length(xpol_inter)
    w = pol(xpol_inter(i),ypol_inter(i));
    xiw = w*xi0';
    % (m,m,m) --> (rad,rad,m) %
    % sph_iw = xyz2latlonr(xiw);
    % [delta,alpha,1] - [rad,rad,m]
    disp(i);disp(w)
    % delta2(i) = sph_iw(1)*180/pi; % degree
    % alpha2(i) = sph_iw(2)*12/pi; % hour angle
end
```

```
     1

    1.0000    0.0000    0.0000
         0    1.0000   -0.0000
   -0.0000    0.0000    1.0000

     2

    1.0000    0.0000    0.0000
         0    1.0000   -0.0000
   -0.0000    0.0000    1.0000

     3

    1.0000    0.0000    0.0000
         0    1.0000   -0.0000
```

```
-0.0000    0.0000    1.0000

  4

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

  5

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

  6

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

  7

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

  8

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

  9

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 10

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 11

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 12

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 13

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 14
```

```
 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 15

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 16

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 17

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 18

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 19

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 20

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 21

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 22

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 23

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000

 24

 1.0000    0.0000    0.0000
      0    1.0000   -0.0000
-0.0000    0.0000    1.0000
```

```
    25

    1.0000    0.0000    0.0000
         0    1.0000   -0.0000
   -0.0000    0.0000    1.0000
```

- Polar motion matrix W for a given time (hourly between 2021-06-11 & 2021-06-12)

```
%delta2;
%alpha2;
```

4.

```
clc
clear

%% ICRF3 catalog
%0454+844
a04 = [5*360/24 8 42.36351222]; % alpha - [deg min sec]
d04 = [84 32 04.5441733]; % delta - [deg min sec]
a04 = dms2dd(a04); d04 = dms2dd(d04); % Convert to [dec deg]
%1101-536
a1101 = [11*360/24 3 52.22168463];
d1101 = -1*[53 57 00.6966389];
a1101 = dms2dd(a1101); d1101 = dms2dd(d1101);
%1111+149
a1111 = [11*360/24 13 58.69508613];
d1111 = [14 42 26.9526507];
a1111 = dms2dd(a1111); d1111 = dms2dd(d1111);
%1738+499
a17 = [17*360/24 39 27.39049431];
d17 = [49 55 03.3683385];
a17 = dms2dd(a17); d17 = dms2dd(d17);
%Spherical Coordinate of 4 Objects
obj1 = [d04,a04,1]; obj2 = [d1101,a1101,1];
obj3 = [d1111,a1111,1]; obj4 = [d17,a17,1];

%Cartesian Coordinate of 4 Objects
xi0_1 = latlonr2xyz(obj1),...
xi0_2 = latlonr2xyz(obj2),...
xi0_3 = latlonr2xyz(obj3),...
xi0_4 = latlonr2xyz(obj4),...

%Berlin
```

```
xi0_1 = 1×3
   -0.9281    0.2401    0.2844
xi0_2 = 1×3
    0.1117   -0.8488    0.5168
xi0_3 = 1×3
    0.1592   -0.5159    0.8417
xi0_4 = 1×3
   -0.3506   -0.8723   -0.3409
```

```
lat_berlin = [52 36 0];% deg min sec
```

```
lon_berlin = [13 24 0];% deg min sec
lat_berlin = dms2dd(lat_berlin); lon_berlin = dms2dd(lon_berlin);
berlin = [lat_berlin,lon_berlin,1]
```

```
berlin = 1×3
   52.6000   13.4000    1.0000
```

```
%polar motion
[year,month,day,mjd,xpol,ypol,dUT1,LOD,dX,dY...
s_xpol,s_ypol,s_dUT1,s_LOD,s_dX,s_dy] = textread('IAU1980_body2021.txt');

% Xpol,Ypol between 2021-06-11 & 2021-06-12
%Row 162 - 2021-06-11
%Row 163 - 2021-06-12
xpol_inter = interp1(xpol(162:163),1:(1/24/60):2);%in min. resolution
ypol_inter = interp1(ypol(162:163),1:(1/24/60):2);%in min. resolution

% JD in 2021-06-11 & 12 with min. resolution
mm=6;yyyy = 2021;
dd=1; ut1=1:24; minute=1:60; second=0;
j = 1;
for ut1 = 1:24
    % Seperated Each Hour
    jd = gre2jd(yyyy,mm,dd,ut1,minute,second);
    % JD of 1 min in Specific hr
    jd = jd(1:60); % Extract only Julian Date
    jd_all(j:j+59) = jd; %Insert Each Year of JD value in 1 hour
    j = j+60;
end
% The final time
lastmin = gre2jd(2021,6,12,0,0,0);
jd_all(1441) = lastmin(1);
jd_all;
% All JD in one day with min resolution


for i = 1:length(xpol_inter)

    t = (jd_all(i) - 2451545.0)/36525;
    GMST(i) = (F(jd_all(i))*86400 + 24110.54841 - 86400/2 + ...
        8640184.812866 * t + 0.093104 * t * t - ...
        6.2e-6 * t * t * t)/3600*60; % [min]
    GMST(i) = rem(GMST(i),60);

    w = pol(xpol_inter(i),ypol_inter(i));
    %Object 1
    xg_1 = ref3d(1)*rot3d(90-lat_berlin,2)*rot3d(lon_berlin,3)*...
    w*rot3d(GMST(i),3)*nut(jd_all(i))*prec(jd_all(i))*xi0_1';
    %sph_xg = xyz2latlonr(xg)
    A_1(i) = atan2(xg_1(2),xg_1(1)); %rad
    E_1(i) = atan(xg_1(3)/sqrt(xg_1(1)^2+xg_1(2)^2));%rad

    %Object 2
    xg_2 = ref3d(1)*rot3d(90-lat_berlin,2)*rot3d(lon_berlin,3)*...
```

```
    w*rot3d(GMST(i),3)*nut(jd_all(i))*prec(jd_all(i))*xi0_2';
    %sph_xg = xyz2latlonr(xg)
    A_2(i) = atan2(xg_2(2),xg_2(1)); %rad
    E_2(i) = atan(xg_2(3)/sqrt(xg_2(1)^2+xg_2(2)^2));%rad

    %Object 3
    xg_3 = ref3d(1)*rot3d(90-lat_berlin,2)*rot3d(lon_berlin,3)*...
    w*rot3d(GMST(i),3)*nut(jd_all(i))*prec(jd_all(i))*xi0_3';
    %sph_xg = xyz2latlonr(xg)
    A_3(i) = atan2(xg_3(2),xg_3(1)); %rad
    E_3(i) = atan(xg_3(3)/sqrt(xg_3(1)^2+xg_3(2)^2));%rad

    %Object 4
    xg_4 = ref3d(1)*rot3d(90-lat_berlin,2)*rot3d(lon_berlin,3)*...
    w*rot3d(GMST(i),3)*nut(jd_all(i))*prec(jd_all(i))*xi0_4';
    %sph_xg = xyz2latlonr(xg)
    A_4(i) = atan2(xg_4(2),xg_4(1)); %rad
    E_4(i) = atan(xg_4(3)/sqrt(xg_4(1)^2+xg_4(2)^2));%rad

end
```

```
A_1 = A_1*180/pi;
for m = 1:length(A_1)
    if A_1(m) < 0
        A_1(m) = A_1(m)+360;
    end
end%
A_1,...
E_1 = E_1*180/pi,...

A_2 = A_2*180/pi;
```

```
A_1 = 1×1441
   62.4816   63.2762   64.0683   64.8581   65.6455   66.4309   67.2142   67.9957 ···
E_1 = 1×1441
    0.1372    0.6792    1.2251    1.7746    2.3277    2.8843    3.4441    4.0072 ···
```

```
for n = 1:length(A_2)
    if A_2(n) < 0
        A_2(n) = A_2(n)+360;
    end
end%
A_2,...
E_2 = E_2*180/pi,...

A_3 = A_3*180/pi;
```

```
A_2 = 1×1441
  323.2336  324.0127  324.7947  325.5796  326.3675  327.1583  327.9520  328.7486 ···
E_2 = 1×1441
    2.2243    1.8631    1.5086    1.1609    0.8201    0.4863    0.1595   -0.1600 ···
```

```
for o = 1:length(A_3)
    if A_3(o) < 0
```

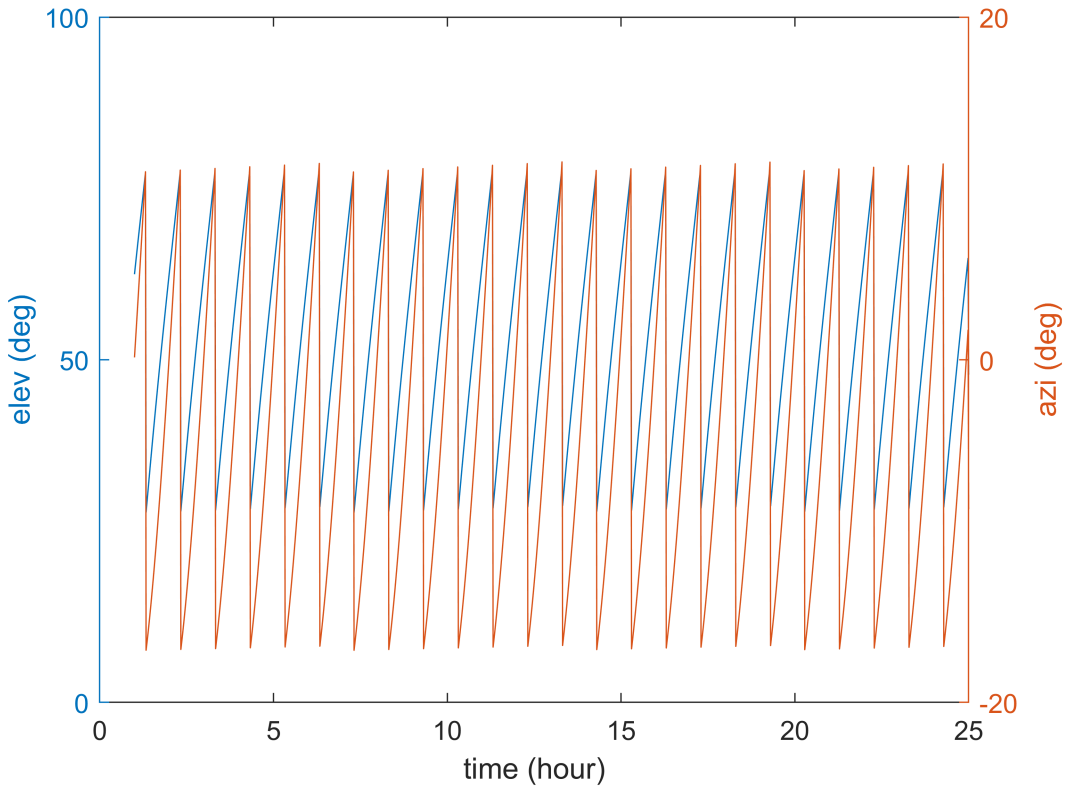
```
        A_3(o) = A_3(o)+360;
    end
end%
A_3,...
E_3 = E_3*180/pi,...

A_4 = A_4*180/pi;
```

```
A_3 = 1×1441
  330.3075  330.8189  331.3325  331.8482  332.3660  332.8858  333.4076  333.9315 ···
E_3 = 1×1441
   28.4100   28.1106   27.8161   27.5263   27.2414   26.9614   26.6862   26.4161 ···
```

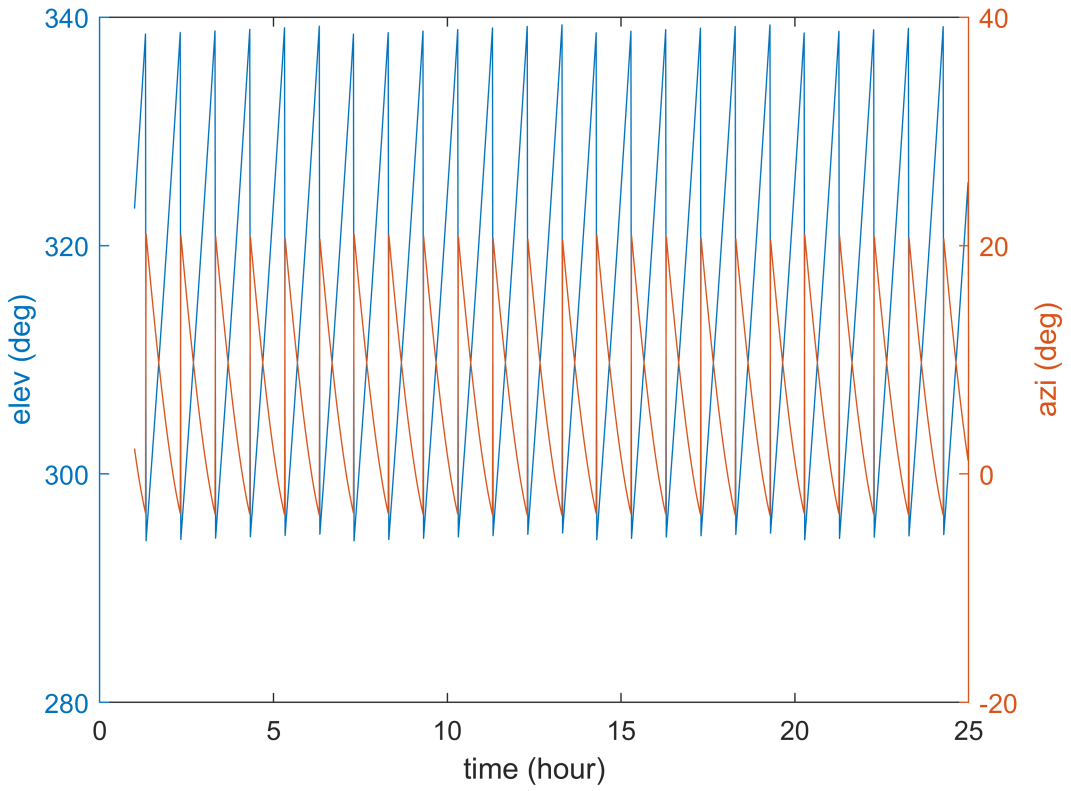
```
for q = 1:length(A_4)
    if A_4(q) < 0
        A_4(q) = A_4(q)+360;
    end
end%
A_4,...
E_4 = E_4*180/pi,...

% Time plot obj 1
```

```
A_4 = 1×1441
  334.5997  336.2015  337.8208  339.4570  341.1090  342.7761  344.4571  346.1509 ···
E_4 = 1×1441
  -55.3541  -55.6077  -55.8455  -56.0674  -56.2729  -56.4616  -56.6334  -56.7879 ···
```

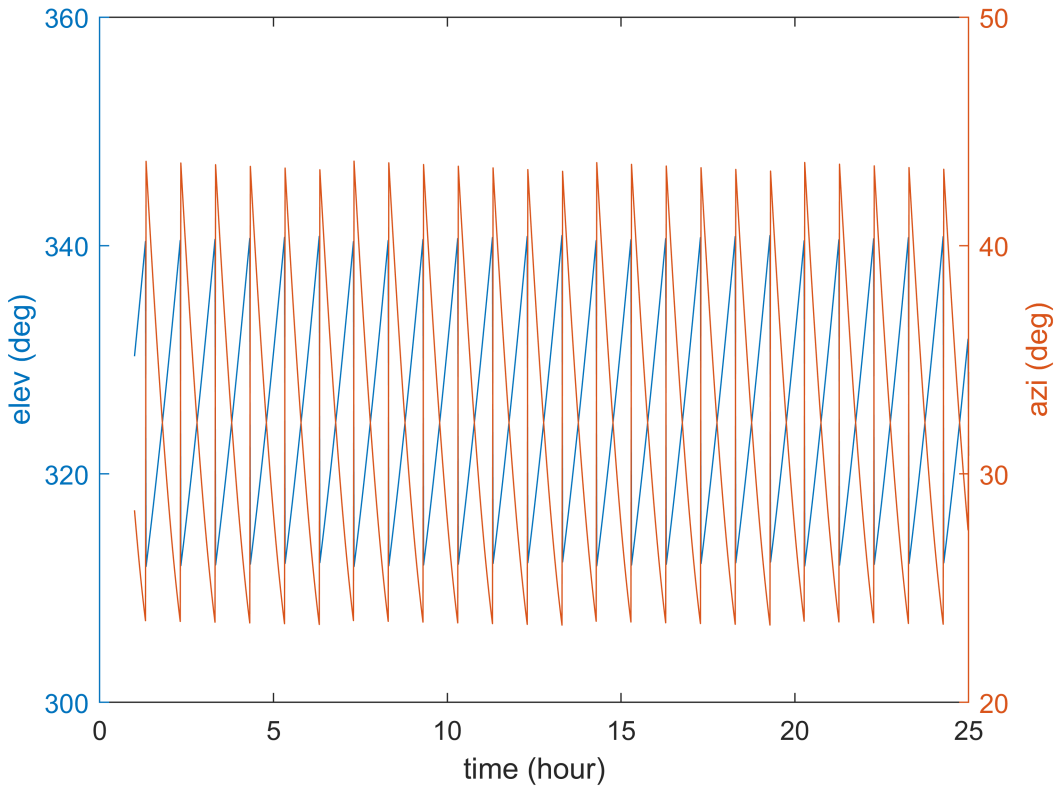
```
figure(1)
xaxis = linspace(1,25,1441);
fig1 = plotyy(xaxis,A_1,xaxis,E_1);
xlabel('time (hour)')
ylabel(fig1(1),'elev (deg)')
ylabel(fig1(2),'azi (deg)')
```



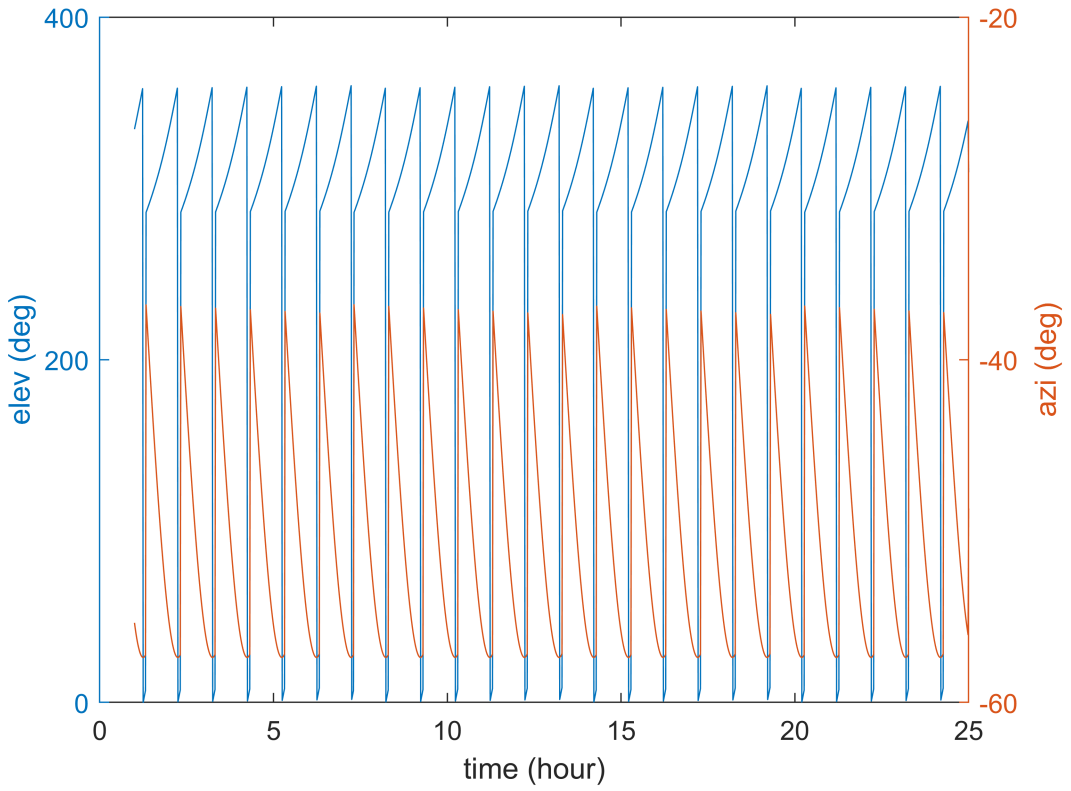

```
% Time plot obj 2
figure(2)
fig2 = plotyy(xaxis,A_2,xaxis,E_2);
xlabel('time (hour)')
ylabel(fig2(1),'elev (deg)')
ylabel(fig2(2),'azi (deg)')
```



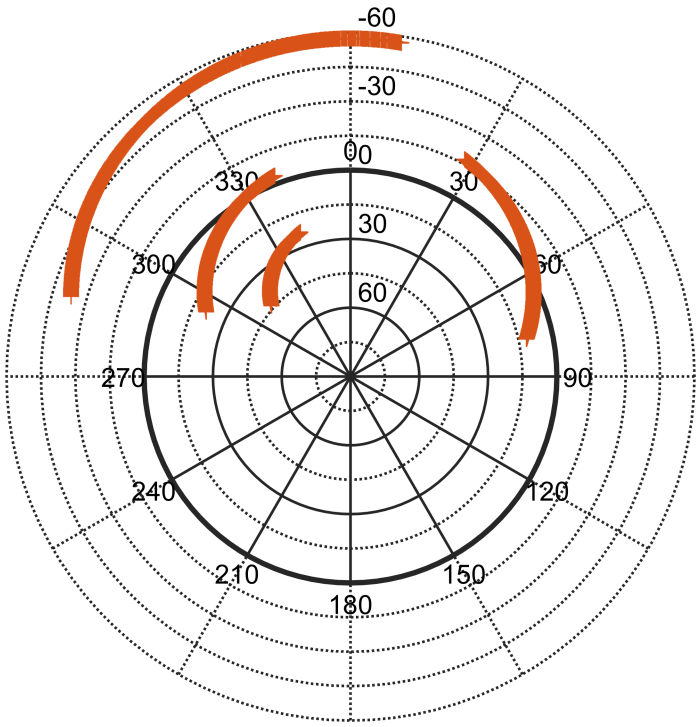

```
% Time plot obj 3
figure(3)
fig3 = plotyy(xaxis,A_3,xaxis,E_3);
xlabel('time (hour)')
ylabel(fig3(1),'elev (deg)')
ylabel(fig3(2),'azi (deg)')
```




```
% Time plot obj 4
figure(4)
fig4 = plotyy(xaxis,A_4,xaxis,E_4);
xlabel('time (hour)')
ylabel(fig4(1),'elev (deg)')
ylabel(fig4(2),'azi (deg)')
```




```
%Sky plot of 4 objs
figure(5)
all_azi = [A_1 A_2 A_3 A_4];
all_elev = [E_1 E_2 E_3 E_4];
skyplot(all_azi,all_elev,'+')
```




```
figure(6)
skyplot(all_azi,all_elev,'c+:') % Changed Style
```