Contents


```
% Hw4.5
close all; clear all; clc;
```

4.5.a)

```
DU = 6378.137;  %km
TU = 806.80415; %sec
VU = DU/TU;

% Earth physical constants from Vallado
muearth = 398600.4418;              % [km^3/sec^2]
reearth =   DU;               % [km] mean equatorial radius
rotEarthRad = 0.0000729211585530;  % [rad/sec]
rotEarthDay = 1.0027379093;  %rev/day
rotEarthDay = rotEarthRad*3600*24/(2*pi);
e2earth =      0.006694385000;      % oblate eccentricity squared

% Greenwich Sidereal Time at 0000h 1 January 2012 UTC
% from US Naval Observatory website
gst2012start = 6.6706801; % [sidereal hours] from vernal equinox

%convert to rad
gst2012start = gst2012start * 2*pi/24;    %[rad]

%tracking station information
track_lon = -(110 + 52/60 + 42/3600);   %deg
track_lat = 31 + 40/60 + 52/3600;       %deg
track_alt = 2.577;                      %km
track_UTC_offset = 7;       %hours behind UTC

track_lon = track_lon *pi/180;          %convert to rad
track_lat = track_lat *pi/180;          %convert to rad


%data collected from tracking station
time_obs = UTC_time(9,4,2012,18,54,0,track_UTC_offset);
rho = 39899.01730557;               %km
Az = 89.78381848      *pi/180;      %rad
El = 63.65779556      *pi/180;      %rad
rho_dot = 0.59337565;               %km/s
Az_dot = -0.00630053  *pi/180;      %rad/s
El_dot = 0.00299054   *pi/180;      %rad/s

% %data for checking purposes.  CHECK WORKS!!!
% rho = 35100; %[km]
% Az = 180*pi/180; % [rad]
```

```
% El = 55*pi/180; % [rad]
% rho_dot = 0; % [km/sec]
% Az_dot = 0*pi/180; % [rad/sec]
% El_dot = 0*pi/180; % [rad/sec]


%find R and V from these measurements in SEZ frame
a_R_s__sez = [-rho*cos(Az)*cos(El);
               rho*sin(Az)*cos(El);
               rho*sin(El)];

sez_V_s__sez = ...
    [-rho_dot*cos(Az)*cos(El) + rho*sin(Az)*Az_dot*cos(El) + rho*cos(Az)*sin(El)*El_
      rho_dot*sin(Az)*cos(El) + rho*cos(Az)*Az_dot*cos(El) - rho*sin(Az)*sin(El)*El_
      rho_dot*sin(El) + rho*cos(El)*El_dot];

%Express ground station in ECEF

o_R_a__ecef = Geodetic_To_ECEF(track_lat, track_lon, track_alt);

ecef__C__sez = ...
    [sin(track_lat)*cos(track_lon), -sin(track_lon), cos(track_lat)*cos(track_lon);
     sin(track_lat)*sin(track_lon),  cos(track_lon), cos(track_lat)*sin(track_lon);
    -cos(track_lat),                 0,              sin(track_lat)];

eci_omega_ecef__eci = [0; 0; rotEarthRad];

% Find angle of Greenwich meridian from vernal equinox [0, 2*pi)
% theta_g = mod(gst2012start + rotEarthDay*(time_obs - 1)*2*pi,2*pi);
theta_g = siderealTime(time_obs);

% Convert ECI coordinates to ECEF coordinates
eci__C__ecef = [cos(theta_g) -sin(theta_g) 0; sin(theta_g) cos(theta_g) 0; 0 0 1];

% Calculate inertial R
o_R_s__eci = eci__C__ecef*(o_R_a__ecef + ecef__C__sez*a_R_s__sez)

eci_V_s__eci = eci__C__ecef*ecef__C__sez*sez_V_s__sez + cross(eci_omega_ecef__eci,o_
```

```
o_R_s__eci =

   1.0e+04 *

   -3.1756
    2.4261
    2.2167


eci_V_s__eci =

   -0.4232
   -1.4048
    2.4162
```

4.5.b)

```
%convert to canonical units
r = o_R_s__eci/DU;
v = eci_V_s__eci/VU;

[a ecc inc raan aop nu0 meanmotion M0] = getOrbitalElements(r,v);

%convert back from canonical units
a = a*DU;
meanmotion = meanmotion* (1/TU) * (1/(2*pi)) * 60*60*24; %rev/day

disp(['a = ' num2str(a) ' km'])
disp(['e = ' num2str(ecc)])
disp(['i = ' num2str(inc*180/pi) ' deg'])
disp(['raan = ' num2str(raan*180/pi) ' deg'])
disp(['aop = ' num2str(aop*180/pi) ' deg'])
disp(['nu0 = ' num2str(nu0*180/pi) ' deg'])
disp(['n = ' num2str(meanmotion) ' rev/day'])
disp(['M0 = ' num2str(M0*180/pi) ' deg'])
```

```
a = 42161.7444 km
e = 0.26743
i = 63.9396 deg
raan = 126.8815 deg
aop = 270.256 deg
nu0 = 122.4252 deg
n = 1.0028 rev/day
M0 = 93.7367 deg
```

4.5.c)

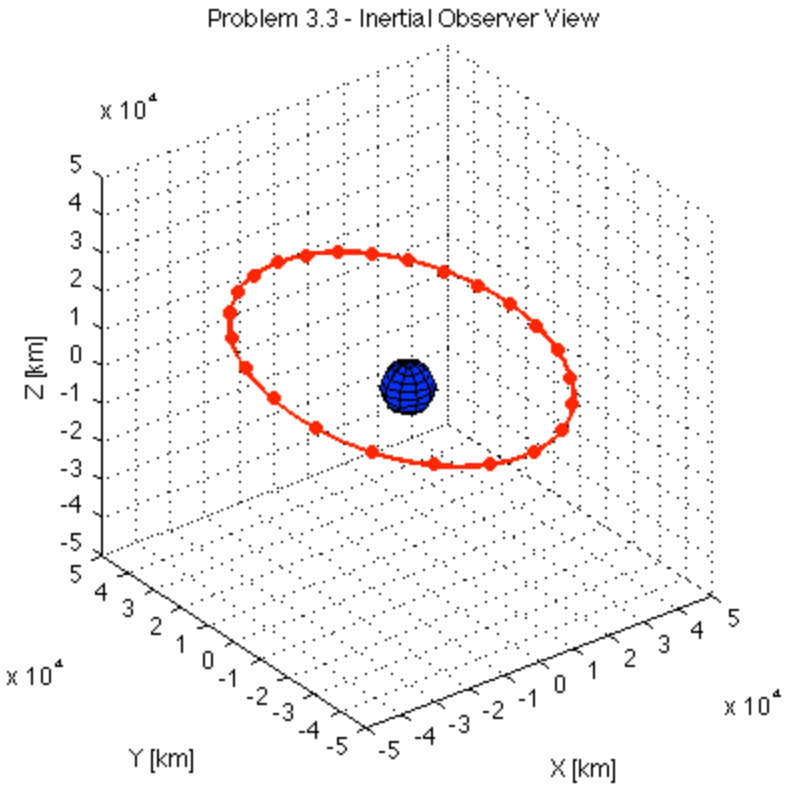
```
disp('This orbit is: direct, elliptical, inclined, geosynchronous')
```

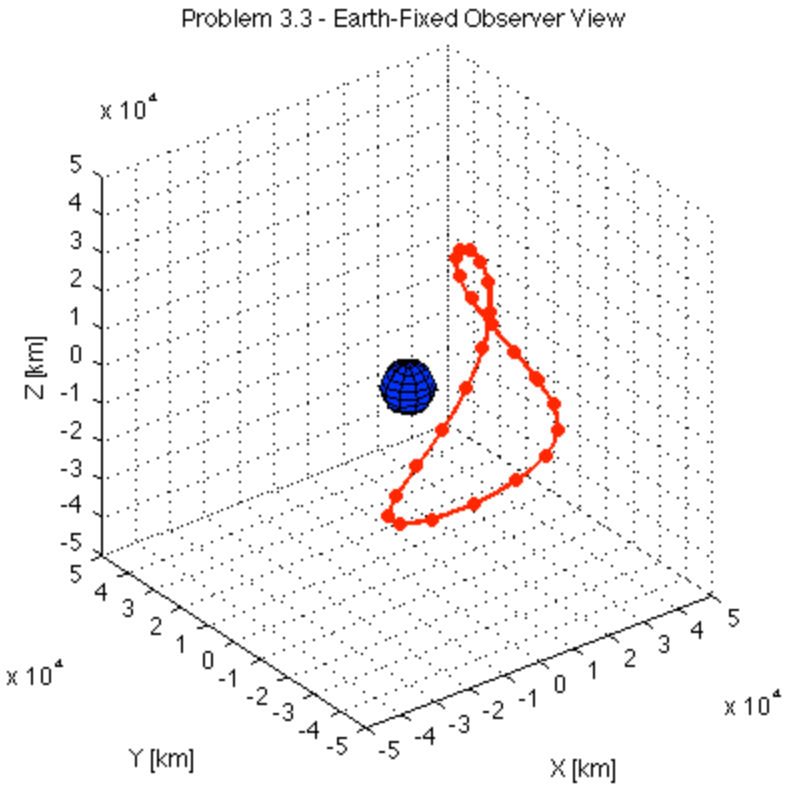
```
This orbit is: direct, elliptical, inclined, geosynchronous
```

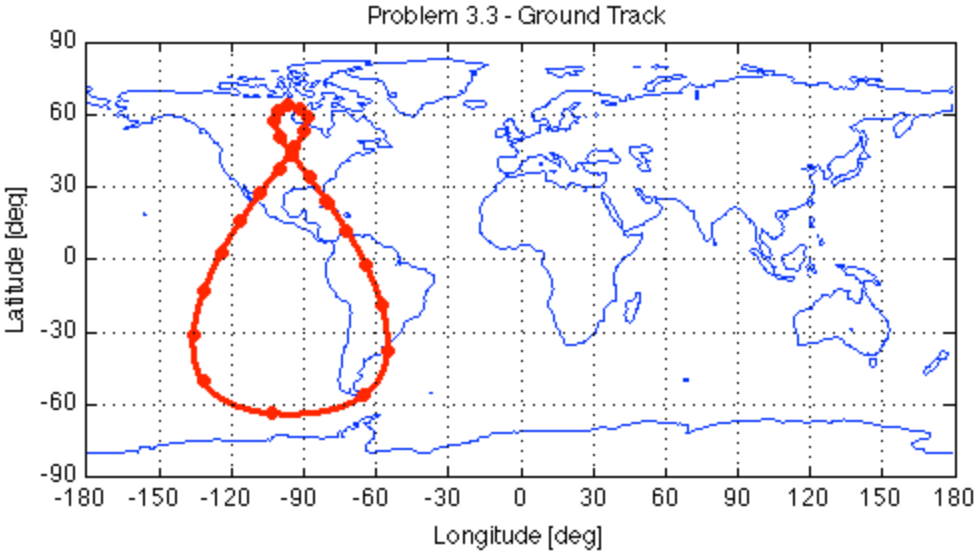
4.5.d)

```
path(path,'Hw3')

orbitalElements.a = a;
orbitalElements.e = ecc;
orbitalElements.i = inc;
orbitalElements.raan = raan;
orbitalElements.omega = aop;
orbitalElements.nu0 = nu0;
orbitalElements.n = meanmotion;
orbitalElements.M0 = M0;
orbitalElements.t0 = time_obs;

startTime = UTC_time(1,5,2012,0,0,0,0);
stopTime = startTime + 1;
```

```
plotOrbit(orbitalElements, startTime, stopTime, 1)
```







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