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ME 356- Astrodynamics
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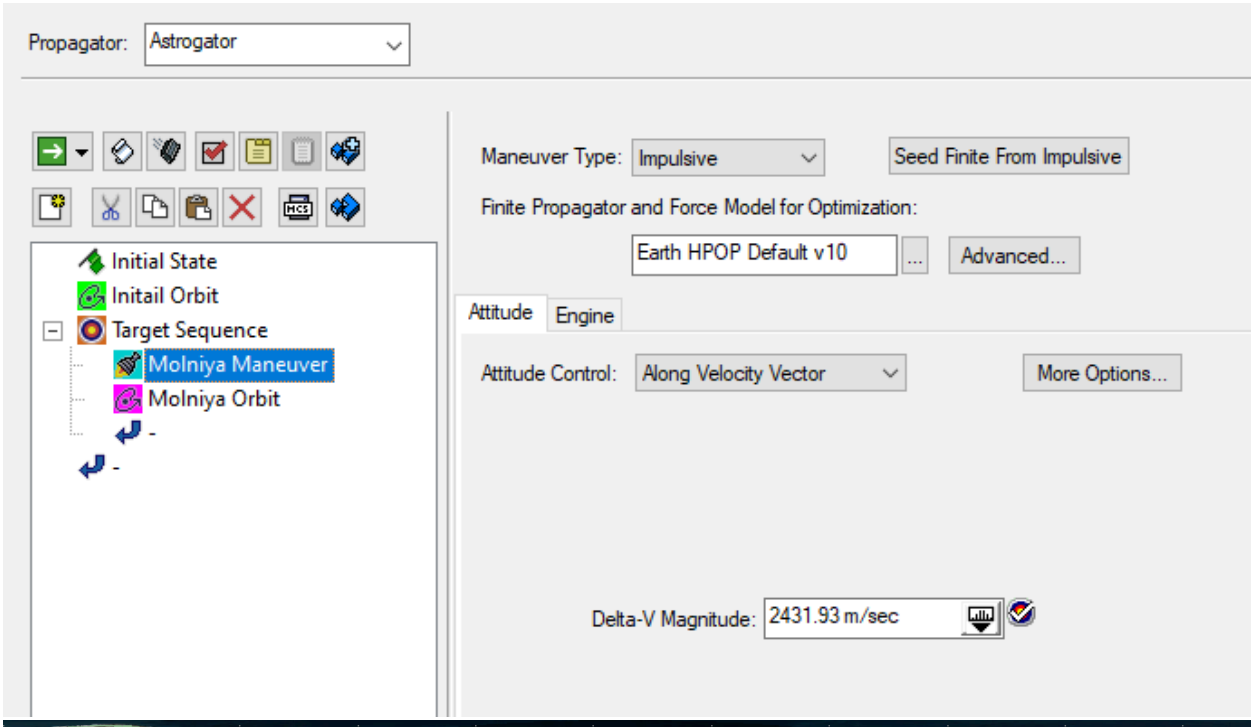
Project 1-Molniya Orbit Maneuver Report

1) Part 1 required looking up the coordinates of the cosmodrome in order to calculate azimuth angle with the given orbit inclination. Using the equation we discovered in class, I calculated the azimuth to be 40.1029 degrees. To solve for Delta V of the maneuver, I used the desired period to determine the semi-major axis length of the new orbit since we only know the period and its perigee. From there I determined the energy it would require to have that semimajor axis length and eccentricity, then using that energy, I solved for what the velocity at perigee would have to be to create that orbit. Finally, I simply subtracted the initial velocity at perigee from the desired orbit required velocity at perigee to determine the correct Delta V for the instantaneous maneuver, being 2.4319 km/s.

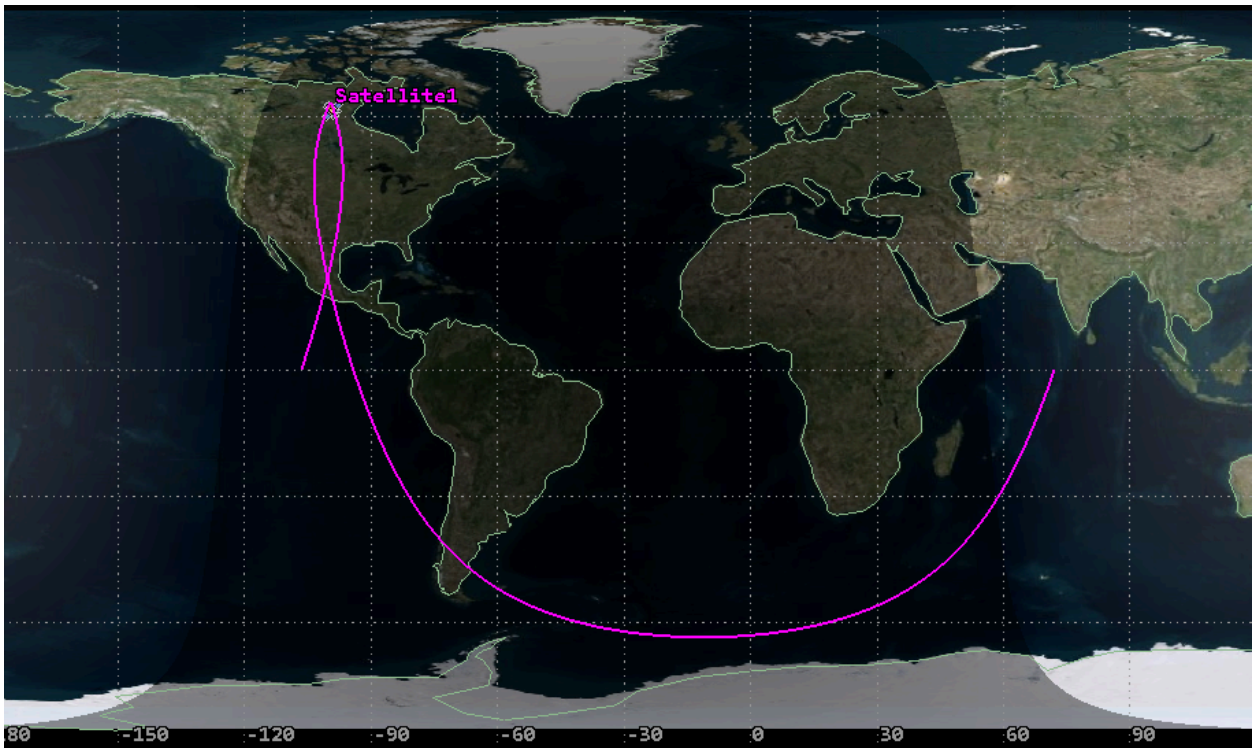
```
%Project 1 Calculations
clc
mu=398600;
R1=500+6378;%km
T=11.9616*3600; %seconds
incl=63.4;%degrees
w=270;%degrees
%Launch Location: Baikonur
%Longitude and Latitude:
lat=45.9646;%degrees
long=63.3052;%degrees

%Calculating Azimuth in degrees
azimuth=asind((cosd(incl)/(cosd(lat)))); %degrees

%Calculating Delta V in km/s
Vp1=sqrt(mu/R1);                %km/s
h=Vp1*R1;                       %km^2/s
a=(T*sqrt(mu)/(2*pi))^(2/3);    %km
R2a=2*a-R1;                     %km
e=(R2a-R1)/(R2a+R1);
h2=sqrt(a*mu*(1-e^2));          %km^2/s
Vp2=h2/R1;                      %km/s
deltaV=Vp2-Vp1;                  %km/s

%print
fprintf("Azimuth: "+azimuth +" degrees");
fprintf("\n")
fprintf("\n")
fprintf("delta V: "+deltaV +" km/s");
fprintf("\n")
```

```
Command Window
  Azimuth: 40.1029 degrees

  delta V: 2.4319 km/s
fx >>
```

2) For part 2, I set the targeter to follow or maintain the variables listed in the constraint list for the maneuver, which calculated Delta V at 2431.93 m/s, exactly the same as calculated in Matlab. This created the desired effect of the Molniya orbit minus the precession that allows the orbit to be maintained over Russia and the US. In my simulation, the orbital ground path drifted to the west, remaining stagnant when viewing Earth from the 1 year orbit relative to the sun. Because the orbit is not precessing due to Earth's mass distribution, the orbit fails to stay in place. Shown below are: the target sequence calculated Delta V, images of the satellite passing over Russia and the United States, , the control/constraint list detailing the orbit and maneuver and the final, elliptical orbit.



Control	New Value	Last Update	Constraint	Desired	Achieved	Difference	Tolerance
Molniya_Maneuver : ImpulsiveMnvr.Pointing.Spherical.Magnitude	2431.93 m/sec	0 m/sec	Molniya_Maneuver : Altitude Of Periapsis	500 km	499.911 k	-0.089013	0.1 km
			Molniya_Maneuver : Argument of Periapsis	270 deg	269.771	-0.22867 d	0.1 deg
			Molniya_Maneuver : Inclination	63.4 deg	63.399 d	-0.001014	0.1 deg
			Molniya_Maneuver : Orbit Period	43061.8 sec	43064.5	2.7341 se	0.1 sec


Satellite1
-180
-150
-120
-90
-60
-30
0
30
60
90