

Indian Institute of Space Science and Technology

Thiruvananthapuram



AE313 Space Flight Mechanics Assignment 2

Lambert's Problem and Lunar Trajectory

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I. Lambert's Problem

Two position vectors and time elapsed are given. The Lambert's problem was solved and the orbit parameters were obtained.

Input data:

```
Gravitational parameter = 398600 km3/s2  
r1 = [5644, -2830, -4170] km  
r2 = [-2240, 7320, -4980] km  
Elapsed time = 1200 s
```

Solution:

```
v1 = [-4.132, 9.012, -4.378] km/s  
v2 = [-7.285, 6.320, 2.527] km/s
```

Orbital elements:

```
Angular momentum = 76096.373 km2/s  
Eccentricity = 1.201  
Inclination = 59.0184 deg  
RA of ascending node = 130.0069 deg  
Argument of perigee = 259.9796 deg  
True anomaly initial = 39.9772 deg  
True anomaly final = 60.5220 deg  
Semimajor axis = -32922.324 km  
Periapse radius = 6601.823 km
```

After it the ground plot and orbit plot were plotted.

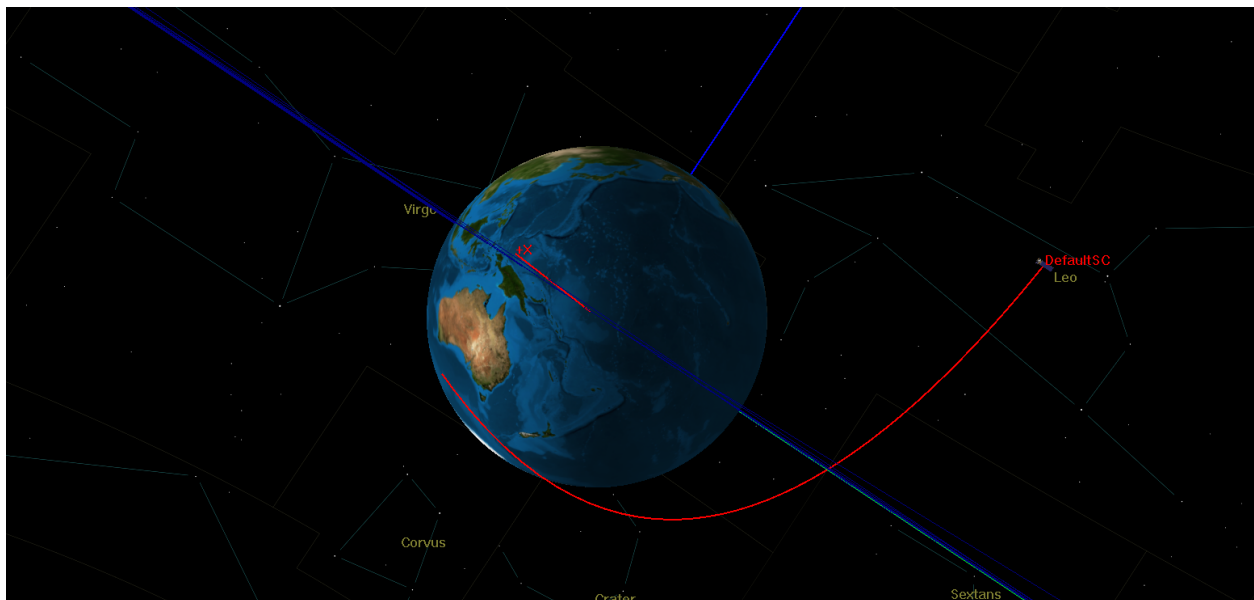


Figure 1. Orbit

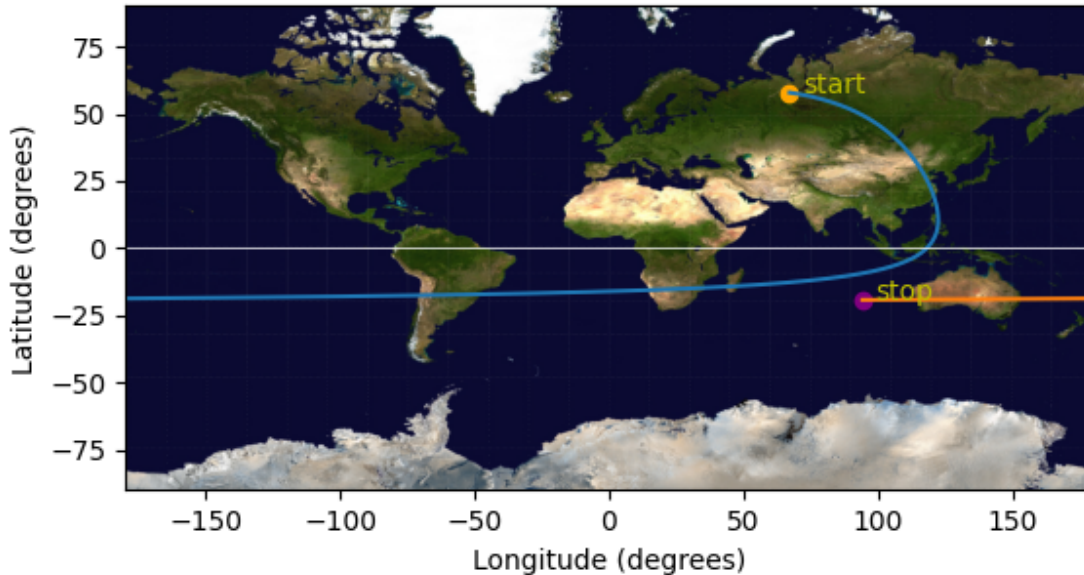


Figure 2. Ground Track

II. Lunar Trajectory Problem

We have been given that the satellite is in (Earth Parking Orbit) EPO. The point of firing the thrusters is $5053.01 \text{ I} + 4239.98 \text{ J} + 1163.10 \text{ K}$. The location of patch point with respect to earth is $-315412.03 \text{ I} - 70009.17 \text{ J} + 1909.70 \text{ K}$. Time taken to reach the patch point from EPO is taken as 20 hrs. Lambert's Problem is solved to find the Parameters for the Trajectory.

Input data:

Gravitational parameter (km^3/s^2) = 398600

r_1 (km) = [5053.01, 4239.98, 1163.1]

r_2 (km) = [-315412, -70009.2, 1909.7]

Elapsed time (s) = 72000

Solution:

v_1 (km/s) = [-8.245, 7.21472, 3.51215]

v_2 (km/s) = [-3.82783, -1.07605, -0.0634938]

Orbital elements:

Angular momentum (km^2/s) = 76743.8

Eccentricity = 1.2226
Inclination (deg) = 21.4777
RA of ascending node (deg) = 13.3753
Argument of perigee (deg) = 37.7666
True anomaly initial (deg) = 350.545
True anomaly final (deg) = 141.308
Semimajor axis (km) = -29864.9
Periapse radius (km) = 6647.95

It is assumed that both the initial orbit and the final orbit is assumed circular for simplification.

$$\begin{aligned}\delta v_1 &= 3.8 km/s \\ \delta v_2 &= 3.7 km/s \\ \delta v &= 7.5 km/s\end{aligned}$$

References

¹Howard D Curtis, Orbital Mechanics for Engineering Students, Fourth Edition