Module 1 Coding Exercises

As a mission designer working for NASA, you have been tasked with creating a trajectory around the Earth and Moon for the Artemis spacecraft. Your task is to solve the following problems. Note that some Matlab code for each of these problems has been created and is available on the Canvas page. The final solution for each problem can be found on the next page.

1. Use two-body motion to propagate motion of a spacecraft for 40 days using the following initial conditions. Plot the trajectory and display the spacecraft's final state vector.

$$\bar{r}_{CMEarth} = (0 \quad 0 \quad 0)\ \text{km}$$
$$\bar{v}_{CMEarth} = (0 \quad 0 \quad 0)\ \text{km/s}$$
$$\bar{r}_{EarthSC} = (-7327.031 \quad -813.869 \quad 0)\ \text{km}$$
$$\bar{v}_{EarthSC} = (1.137 \quad -10.237 \quad 0)\ \text{km/s}$$

2. Propagate three-body motion (spacecraft, Earth, and Moon) for 40 days with the following starting conditions. Plot the trajectory and display the spacecraft's final state vector with respect to the Earth. Use μ_{Moon} = 4902.8

$$\bar{r}_{CMEarth} = (-4677.975 \quad 0 \quad 0)\ \text{km}$$
$$\bar{v}_{CMEarth} = (0 \quad -0.013 \quad 0)\ \text{km/s}$$
$$\bar{r}_{CMMoon} = (380322.025 \quad 0 \quad 0)\ \text{km}$$
$$\bar{v}_{CMMoon} = (0 \quad 1.012 \quad 0)\ \text{km/s}$$
$$\bar{r}_{EarthSC} = (-7327.031 \quad -813.869 \quad 0)\ \text{km}$$
$$\bar{v}_{EarthSC} = (1.137 \quad -10.237 \quad 0)\ \text{km/s}$$

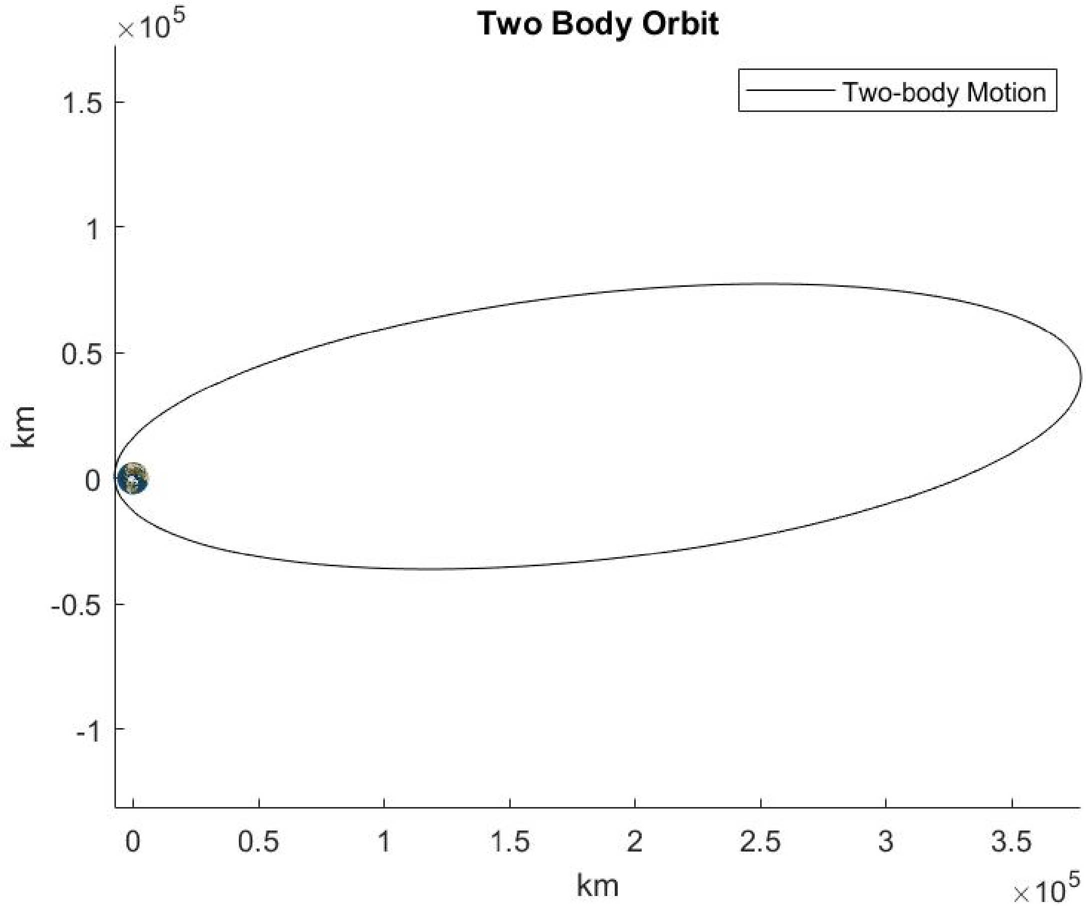
3. Convert the initial conditions and time range from the second problem to a non-dimensional rotating frame assuming that initially the Earth and Moon are along the x-axis of the new frame. Display the spacecraft's initial position and velocity in non-dimensional coordinates.

4. Using the non-dimensional initial conditions from problem 3, propagate the trajectory in the non-dimensional time frame using the Circular Restricted Three-Body Problem. Plot the trajectory in a rotating Earth-Moon coordinate system and display the spacecraft's final state.

5. Convert the final trajectory from problem 4 back into an inertial dimensional coordinate frame. Plot the trajectory and display the spacecraft's final state vector with respect to the Earth.

Problem Solutions

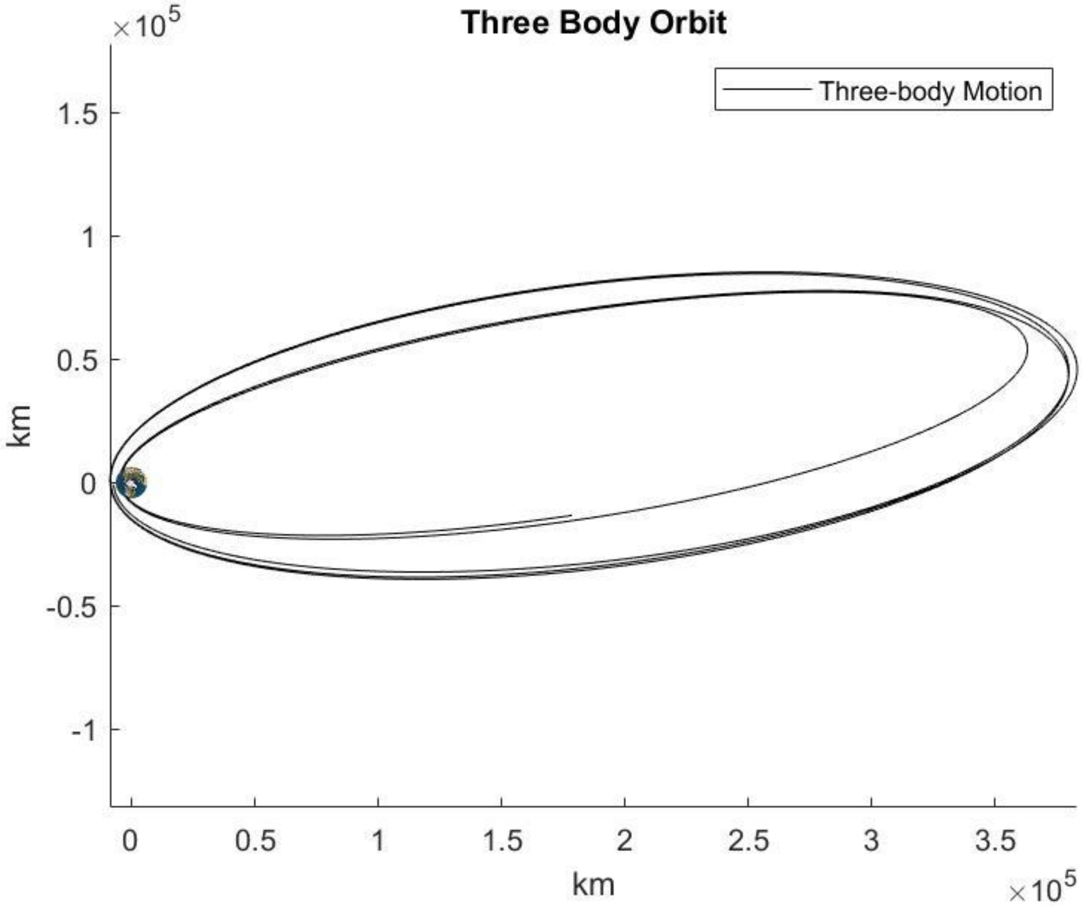
1. Desired plot:



Final state:

$$S = \begin{bmatrix} 117633.557 \\ -36269.861 \\ 0 \\ 2.104 \\ -0.00328 \\ 0 \end{bmatrix}$$

2. Desired plot:



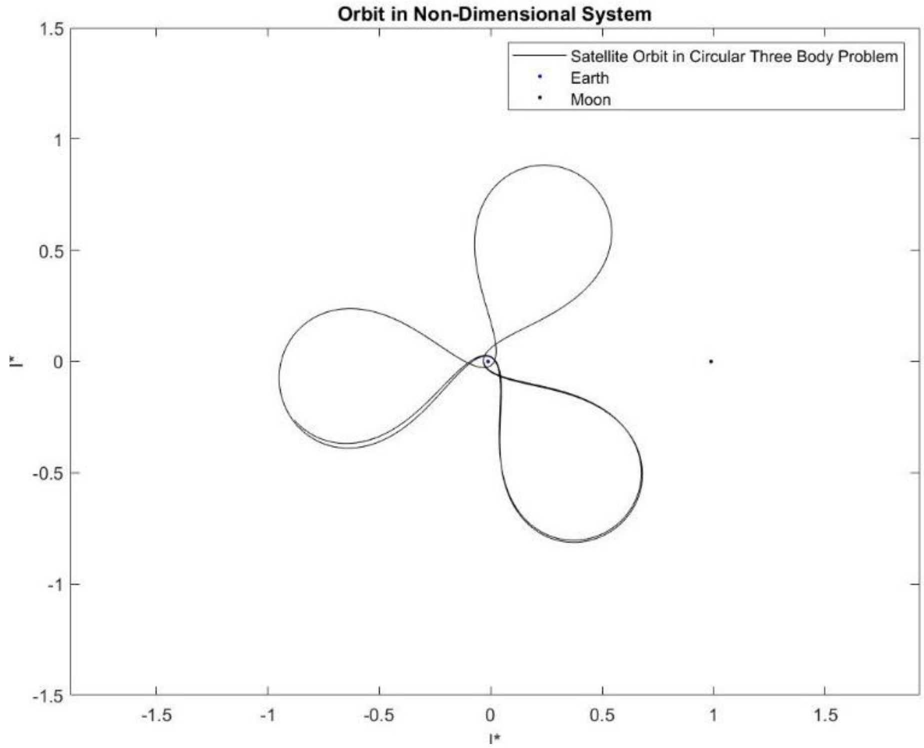
Final state:

$$S = \begin{bmatrix} 159275.635 \\ -12816.769 \\ 0 \\ 1.670 \\ 0.216 \\ 0 \end{bmatrix}$$

3. Initial state:

$$S = \begin{bmatrix} -0.03118 \\ -0.002114 \\ 0 \\ 1.108 \\ -9.974 \\ 0 \end{bmatrix}$$

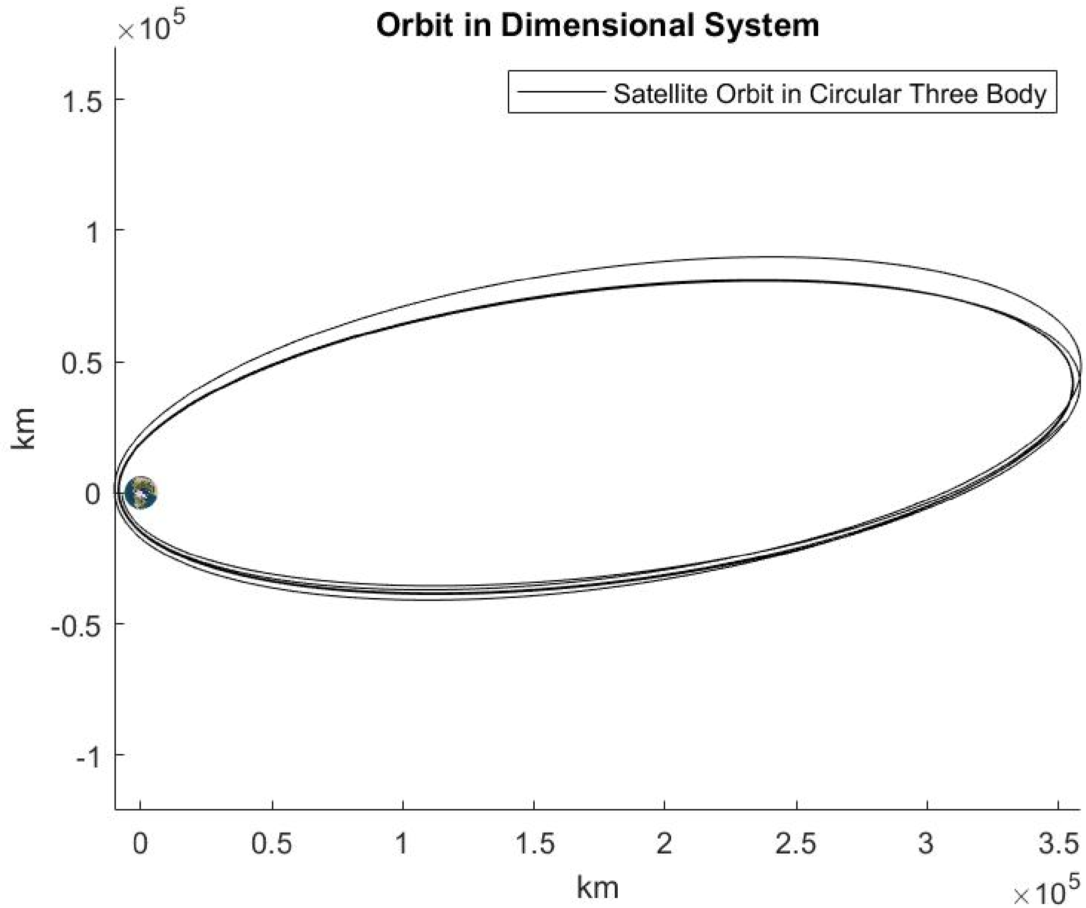
4. Desired plot:



Final State:

$$S = \begin{bmatrix} -0.8801 \\ -0.265 \\ 0 \\ -0.484 \\ 0.550 \\ 0 \end{bmatrix}$$

5. Desired plot:



Final state:

$$S = \begin{bmatrix} 348559.267 \\ 23608.953 \\ 0 \\ 0.293 \\ 0.267 \\ 0 \end{bmatrix}$$