1. The basis in the reference frame, U, is:

This means that the position of the spacecraft expressed in this basis is:

To find the velocity, the transport theorem must be applied:

1. The two-body differential equation is:

First must be calculated. Applying the transport theorem to gives us acceleration:

Substituting into the two-body differential equation:

Separating the equation by vector gives two differential equations:

1. Specific mechanical energy is given as:

Computing the dot product:

To show that specific mechanical energy is constant, we must find the rate of change:

Substituting the differential equations in for and :

1. -
2. Specific angular momentum is defined as:

Taking the cross product:

Taking the magnitude:

This can be rearranged to be:

1. The change of variable for the second differential equation is:

To find a second order differential equation with derivative of with respect to , must be found.

can be found by multiplying:

Taking another derivative gives:

Taking the derivative of with respect to r:

Using the second differential equation:

Solving for dr/dt:

Rearranging:

Now can be calculated:

The second differential equation can be written as