

Homework Assignment #9 (the last), due Thursday, Dec. 1

Part 2 - Analyzing spacecraft motion in the Earth-Moon system using the circular, restricted 3-body model

Instructions: When asked to describe the spacecraft trajectory behavior, please do so in both the rotating frame and the inertial frame. As always, when doing numerical integration, take some time to try different error tolerances or step sizes to verify that your computations are sufficiently accurate.

1. Plot the zero velocity curves for different values of the constant α (or C). Show the different situations that were presented in the 11/22 lecture. Hint: $C = -1.7 = -\alpha$ should produce roughly the first zero velocity curves presented in lecture.
2. Based on the zero-velocity curve analysis and the linear analysis you did in Part 1, characterize the spacecraft motion in the vicinity of L_1 and in the vicinity of L_4 . Be clear about what each type of analysis let's you conclude.
3. Consider the problem of transferring a spacecraft from a lunar orbit to an earth orbit. Assume a value for the Jacobi integral just large enough that the corresponding zero velocity curve indicates a pathway between lunar and earth orbits. Using backward and forward time integration from a point in the vicinity of L_1 , construct a potential transfer trajectory. The transfer strategy would then be to use a propulsive burn (energy increase) to get on this trajectory from lunar orbit and then a second propulsive burn (energy decrease) to get off it into an earth orbit. You only need to construct the potential transfer orbit.
4. Compute a "halo orbit" about L_4 . A halo orbit is a periodic orbit about a Lagrange point. Pick an initial state near L_4 and numerically integrate the equations of motion. See if you get an almost periodic orbit, meaning that it should eventually repeat itself by coming back to the initial state. "Almost" is used because numerically it is difficult to integrate accurately enough that an exact return to the initial state is achieved.

The linear analysis at L_4 should suggest what period to expect. What is the period? Of course if your initial state leads far enough away from L_4 then you may not get a periodic orbit and the linear analysis may not be valid.