ECE 550 PROJECT DESCRIPTION

Instructions: This project is to be performed on an individual basis, namely, you are not allowed to consult anyone else. You will be expected to turn in a report of your work on Friday December 1, 2006.

In an effort to open up the far side of the moon for exploration, studies have been conducted to determine the feasibility of operating a communication satellite around the translunar equilibrium point in the earth-sun-moon system. The desired satellite orbit, known as a halo orbit, is shown in the figure below. The objective of the system is to keep the satellite on a halo orbit trajectory that can be seen from the earth so that the lines of communication are accessible at all times. The communication link is from the earth to the satellite and then to the far side of the moon.

![Diagram of Earth, Moon, and satellite orbits]

The linearized (and normalized) equations of motion of the satellite around the translunar equilibrium point are:

\[
\dot{\mathbf{x}} = 
\begin{bmatrix}
0.0000 & 0.0000 & 0.0000 & 1.0000 & 0.0000 & 0.0000 \\
0.0000 & 0.0000 & 0.0000 & 0.0000 & 1.0000 & 0.0000 \\
0.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0000 & 1.0000 \\
7.3809 & 0.0000 & 0.0000 & 0.0000 & -2.0000 & 0.0000 \\
0.0000 & -2.1904 & 0.0000 & -2.0000 & 0.0000 & 0.0000 \\
0.0000 & 0.0000 & -3.1904 & 0.0000 & 0.0000 & 0.0000 \\
\end{bmatrix}
\begin{bmatrix}
\mathbf{x} \\
\mathbf{u}
\end{bmatrix}
\]
where the state vector \( x \) is the satellite position and velocity (with respect to the three axes) and the input vector \( u = [u_1 \quad u_2 \quad u_3] \) represents the engine thrusts accelerations in the \( \xi, \eta \) and \( \zeta \) directions, respectively.

a) Is the translunar equilibrium point a stable location?
b) Is the system controllable from \( u_i, i = 1, 2, 3 \) acting alone?
c) Design a state feedback controller \( u_2 = [k_1 \quad k_2 \quad k_3 \quad k_4 \quad k_5 \quad k_6]x \) so that the closed-loop system with respect to \( u_2 \) has two dominant poles located at \( 1 \pm j \).
d) Simulate both compensated and uncompensated (controlled and uncontrolled) systems in the time when the engine thruster in the direction of \( \zeta \) accidentally fires with a constant thrust of 0.1 meters per second square over a time period of 0.1 seconds.