AOE 4134 Astromechanics Problem Sheet 12

Due December 11, 2002

Read: Chapter 4, all of: 4.1, 4.2, 4.6, Chapter 3, all of it (3.1, 3.2, 3.3, 3.4)
Chapter 2, Sections 2.6 , 2.8.4, 2.9

55. Given $\vec{r}_0 = 1\hat{i} + 1\hat{j}$ DU and $\vec{V}_0 = 1\hat{k}$ DU/TU. Using the Lagrange functions (f, g, $\dot{f}$, $\dot{g}$ in terms of the change in true anomaly) to determine the position and velocity vectors for the case where $\Delta\nu = 60$ deg. You could write a MATLAB code to have an input of $\vec{r}_0$, $\vec{V}_0$ and $\Delta\nu$, and an output of $\vec{r}$ and $\vec{V}$.

56. Find the position of the satellite if the initial conditions are the same as those in problem (55), at epoch, and 8 time units have passed. I would suggest using the Laplace functions in terms of the change in eccentric anomaly.

57-59. A Global positioning system (GPS) satellite (labeled satellite A) is in a 12 hour circular orbit at an inclination of 55 degrees. The longitude of the ascending node is at 30.0 deg. At 13:25:50.5 EST, on December 10, 2002, the true anomaly (argument of latitude) of that satellite is at 60 degrees. You have a GPS receiver which operates by locating four or more GPS satellites and essentially triangulating. The question is if satellite A is one that is used by your receiver. To be eligible to be used, the elevation angle must be greater than 30 degrees. To solve this problem, carry out the following calculations:

1. Determine the local time (EST using 24 hour clock).
2. Determine UT1 (Greenwich mean time).
3. Determine θ_{gST_0} (Greenwich mean sidereal time).
4. Determine θ_{LST} (Local sidereal time (Blacksburg).
5. Determine the position of the GPS satellite A in the ECI system
6. Determine the transformation matrix $T_{ECI2NED}$
7. Determine the position vector (from the center of the Earth) of the GPS satellite A as represented in the North, East, Down (NED) system.
8. Determine the line of site position vector from the observation site to the satellite ($\vec{\rho}$) as represented in the NED system..
6. Determine the Elevation and Azimuth “look” angles and verify that this satellite can be or cannot be used.

60. Do the following conversions and calculations:

a) 100.5768 deg to hours, minutes, seconds
b) 24110.54841 arc seconds to degrees. Note that this is the GMST at J2000 ($12^h 0^m 0s$ Jan 1 2000)
c) Julian day (JD_0) for Jan 1, 2002, ($0^h 0^m 0^s$)
d) θ_{gST0} for Jan 1, 2002, (0:0:0.0)