ASEN 5010 Homework Assignment No. 4

Due Date April 2, 2013

READ CHAPTERS 1, 2, 3, 4, 8.1

Note: if you don't attempt to solve a problem or sub-problem, then you'll be deducted the points you would have been given. Yes, it is possible to make negative points. For example, if a problem is worth 15 points, and you chose simply ignore it, then you'll receive -15 points for this part. If everything else is correct in the homework, you'll end up with a 70.

Problem 1: S&J, Problem 4.10,

Problem 2: S&J, Problem 4.11,

Problem 3: Develop a program to integrate the equations of motion of a rigid body. The inertia matrix is given by

$$[I] = \begin{bmatrix} 125 & 0 & 0 \\ 0 & 100 & 0 \\ 0 & 0 & 75 \end{bmatrix} \text{ kg m}^2$$

Consider three cases where the body is rotating 1 rad/sec about each principal axis. Integrate the resulting motion and study the angular rates and the resulting attitude (use any attitude coordinates). For each principal axis case, assume first that a pure spin about the principal axis is performed, and then repeat the simulation where a small 0.1 rad/sec motion is present about another principal axis. Discuss the stability of each motion. You should have a total of 6 simulations results in the end.

Problem 4: Consider the general torque-free motion of a rigid body. The rigid body inertia is given in the previous problem. Discuss the stability of the resulting motion by computing the constants of the equivalent Duffing equation. Use your numerical simulation of the previous problem to test free spin cases and verify that the "energy-type" integral is satisfied at all time.

$$\dot{\omega}_i^2 + A_i\omega_i^2 + \frac{B_i}{2}\omega_i^4 = K_i \tag{1}$$

Problem 5: Assuming that $\hat{\boldsymbol{b}}_1$ is aligned with $\boldsymbol{R}_c$, re-derive the relative equilibrium states of a rigid body in a circular orbit.

Problem 6: Determine the gravity gradient torque acting on spacecraft using the MRPs as the attitude measure instead of the 3-2-1 Euler's angles used in class.

Problem 7: Determine the linearized equations of motion of a rigid spacecraft about a gravity gradient relative equilibrium orientation using the MRP attitude coordinates.