ME 596 Spacecraft Dynamics: Homework Assignment 5

Your submission must be submitted as a report, by which I mean your work must be written out as it would be in a report, showing and explaining all your work, and clearly stating your answers using complete sentences and references as appropriate, and the entire assignment must be neatly written or typeset.

You may use `Matlab` or other programming environment to perform the calculations in all of the problems in this assignment, but you must show your work and provide results of intermediate calculations.

Note: Including a `Matlab` program does not qualify as "showing your work."

You must upload your work as a *single* pdf file by 11:59 PM on the due date.

Model the Clementine spacecraft as a 400 kg square prism, 1.88 m high (h) by 1.14 m across (d), with two rectangular solar panels that are 1.5 m square (a), and have an area mass density of 2 kg/m^2 (ρ). The solar panels can rotate about a common axis that passes through the mass center of the spacecraft. You may assume that the rods connecting the solar panels to the spacecraft are massless, and that there is zero clearance between the edges of the solar panels and the prism.

Take the body frame, $\mathcal{F}_b$, to be such that $\hat{\mathbf{b}}_1$ passes from the mass center through one of the solar panels, $\hat{\mathbf{b}}_3$ is the symmetry axis of the prism, and $\hat{\mathbf{b}}_2$ is the remaining orthogonal vector for the reference frame.

Determine the moment of inertia matrix about the mass center of the spacecraft, with all parameters as variables, including the rotation angle of the solar panels (θ). The value of θ is zero when the plane of the solar panels is parallel to the symmetry axis of the prism.

Determine numerically the moment of inertia matrix with given parameters and $\theta = 0$.

Determine numerically the moment of inertia matrix with $\theta = 45°$.

For the $\theta = 45°$ case, determine the principal moments of inertia and principal axes. What is the Euler Angle Φ relating the body frame to this principal frame?

Make a graph of Φ vs. θ for $\theta \in [0, \pi]$.

Write a paragraph addressing the relationship between rotating solar arrays and attitude dynamics. Is it possible for a rotating array to create a situation where the major axis and minor axis "swap" places? If the rotation is not slow, does the angular momentum of the array relative to the spacecraft affect the motion?