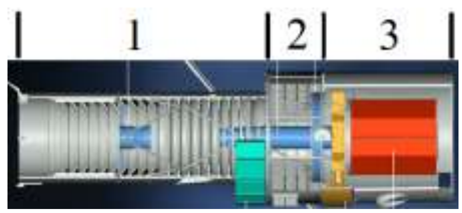
EAE-298 Winter 2016 Homework #3 – *Due Sunday 1/31/16 9pm*

We won't circle back to this for a couple weeks so let's get some practice right now. Most of this should be familiar to you but this is how we can actually apply it to a spacecraft

1. Develop a very simple representation of the Hubble telescope.

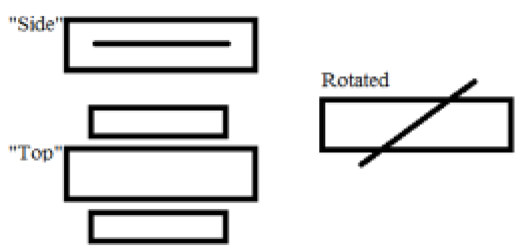
It can be as simple as two thin walled cylinders, a cylinder to cap the end, and two plates to represent the solar panels. You can (but don't have to) ignore the "lens cap" door, the contribution of the arm connecting the solar panel, and the antenna boom. Although we are neglecting them, keep in mind that these could have a non-negligible although small effect. This is especially true for the antennae due to their length. For the purpose of this HW the components are limited; however the same methods would be used regardless of the amount and complexity of components.

Body: three parts



- 1 can be a thin walled cylinder
- 2 can be a thin walled cylinder
- 3 can be a solid cylinder

Solar Panels: two parts



- The two panels can be considered floating plates since we are neglecting the small attachment rod
- Keep in mind that they can be rotated and we need to account for this

Additional notes:

- We are not structural engineers (yet) so don't worry about physically mated surfaces between your objects
- Leave everything as variables at this point so geometry doesn't have to make sense yet
- Doesn't have to be perfect, this is a first pass model. You have to start somewhere!

2. Use this model as a basis to write a function(s) to determine the Mass Center and Inertia Matrix for any location.

- Within reason, we will just worry about points within or right next to Hubble
- You can choose your own axes but some choices may be better than others (you may want to find your principal axis).
- The Mass Center doesn't change so can be a separate program
- You don't have to use integration. You can just use the simplified shapes and the parallel axis theorem then combine them
- Your inputs should be the mass of your parts, the geometry of your parts, the orientation of the solar panels, and the location you want the Inertia with respect to
- Your outputs should be the mass center and a 3x3 inertia matrix (but don't forget that your axis and origin should also be defined for this to be useful)
- You may move the origin of your axis after you determine the mass center, just be careful

3. Write a function to find the current angular momentum relative to the mass center.

- You will need to accept inputs of current angular velocities relative to each axis

4. Choose the optimal location for a torque producing system and explain why you think is the best location.

- For the purpose of this problem it can be within the housing of the telescope
- This will require you to make estimates for your inputs. Use anything published, knowledge of materials, knowledge of real geometry, or even your best guess as a last resort.

5. Using your previous functions, write a program to find the resulting angular acceleration produced from a given torque.

- Assume you have three independent torquers aligned perfectly with each of your axis
- If you were unable to determine the principle axis, center of mass, inertia matrix, or any previous functions then still try to develop a code with variables assuming that these items are known

6. Write what next steps you would take to develop a controller that keeps the craft pointed in a specific direction

- Don't worry about equations, just use words. We will cover this in a couple weeks. I just want you to start thinking about this
- Assume there are other engineers on your team that are really good with sensors, what do you need to tell them to measure and how would you use this?

HW #3 Solution Guidance:

The problems are written in the order necessary to develop your code. The answers won't necessarily be found until you finish part 4.

1. An image (can even be hand drawn) defining your variables and axes. Include CG and location from #4. Suggestion: Don't draw your axis and origin until later, you might end up changing them and don't want to redraw it too many times.
2. Mass Center (single location with reference to something like the end of the spacecraft along the centerline) and Inertia relative to location from #4 (see figure 1. This is the only place the panels will rotate, consider them static otherwise).
3. Plot see figure 2.
4. Location (single location with reference to something like the end of the spacecraft along the centerline or mass center) and explanation.
5. 2 Plots see figure 3 and 4. One plot (f.3) with zero angular velocity on all axes. One plot (f.4) with 0.1 rad/s in each axis. For f.4 just show torque applied to a single axis of your choice.
6. Paragraph form, bullets, or any other form of your choice

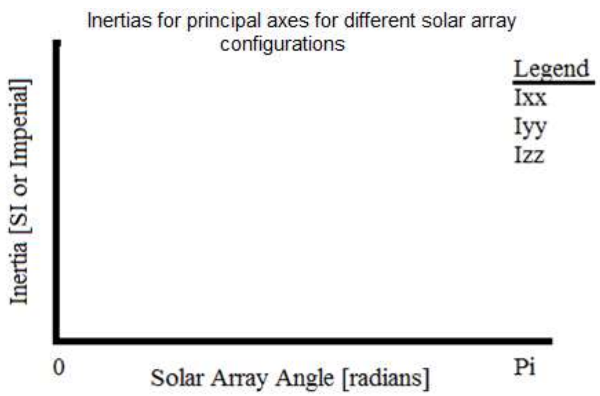


Figure 1

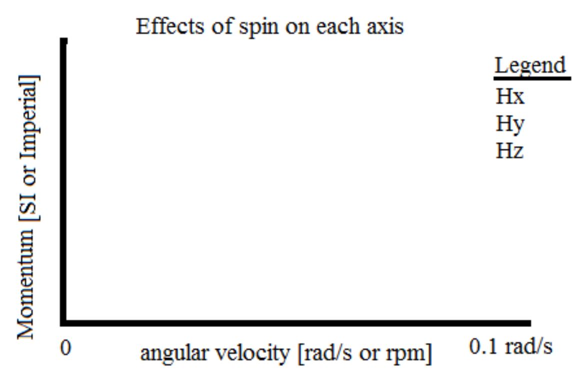


Figure 2

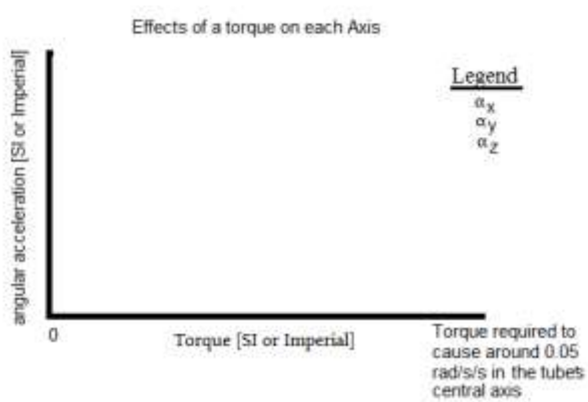


Figure 3

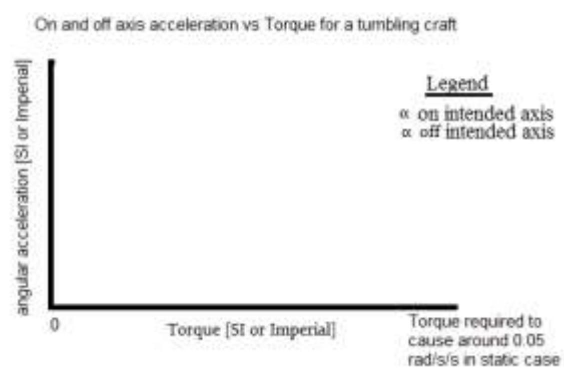


Figure 4