POLITECNICO MILANO 1863

Spacecraft Attitude Dynamics

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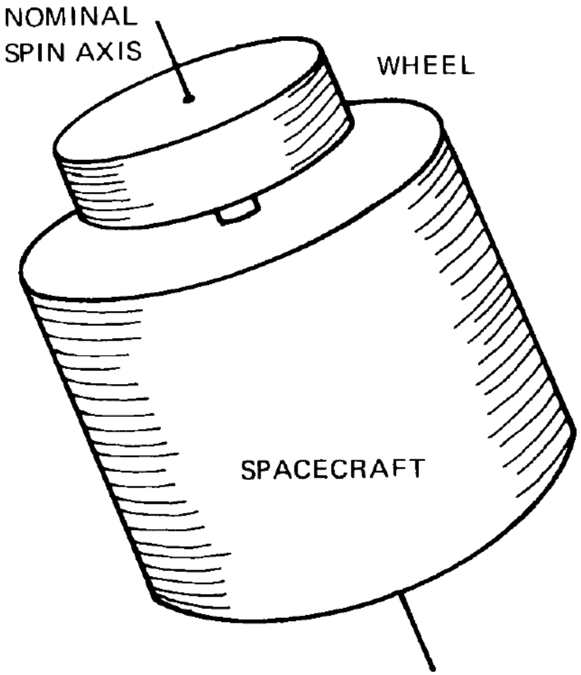
Lab 2 – dual spin stabilization and nutation damping

Task 1: Test the stability of a dual-spin spacecraft

$$I_x = 0.07kgm^2, I_y = 0.0504kgm^2, I_z = 0.0109kgm^2, I_r = 0.005$$



$$I_x\dot{\omega}_x = \left(I_y - I_z\right)\omega_z\omega_y - I_r\omega_r\omega_y$$
$$I_y\dot{\omega}_y = (I_z - I_x)\omega_x\omega_z + I_r\omega_r\omega_x$$
$$I_z\dot{\omega}_z = \left(I_x - I_y\right)\omega_y\omega_x - I_r\dot{\omega}_r$$
$$I_r\dot{\omega}_r = 0$$

$$\omega_x(0) = 1e - 6rad/\sec, \omega_y(0) = 1e - 6rad/\sec, \omega_z(0) = 0.02rad/\sec$$

$$\omega_r(0) = 2\pi rad/\sec$$

Task 2: Implement the dynamics of a fluid-ring damper for a simple spin spacecraft

$I_x = 0.07kgm^2, I_y = 0.0504kgm^2, I_z = 0.0109kgm^2, I_r = 0.005$

$$\begin{cases} I_x\dot{\omega}_x + (I_z - I_y)\omega_z\omega_y + I_r\omega_r\omega_y + I_f\dot{\omega}_f = 0 \\ I_y\dot{\omega}_y + (I_x - I_z)\omega_x\omega_z - I_r\omega_r\omega_x + I_f\omega_f\omega_z = 0 \\ I_z\dot{\omega}_z + \cancel{I_r}\dot{\omega}_r + (I_y - I_x)\omega_x\omega_y - I_f\omega_f\omega_y = 0 \\ I_r\dot{\omega}_r = 0 \\ I_f\dot{\omega}_f + c(\omega_x + \omega_f) = 0 \end{cases}$$

$$c = \frac{I_f I_r \omega_r}{\sqrt{I_x I_y}}$$

$$\Rightarrow I_f I_r \omega_r = c\sqrt{I_x I_y}$$

$$I_f = \frac{c\sqrt{I_x I_y}}{I_r \omega_r}$$

Provide a small initialization error and vary *c. Try to tune the optimal value for c.*

$\omega_x(0) = 2\pi rad/\sec + 1e-06, \omega_y(0) = 1e-06 rad/\sec, \omega_z(0) = 1\text{e}{-}06 rad/\sec$