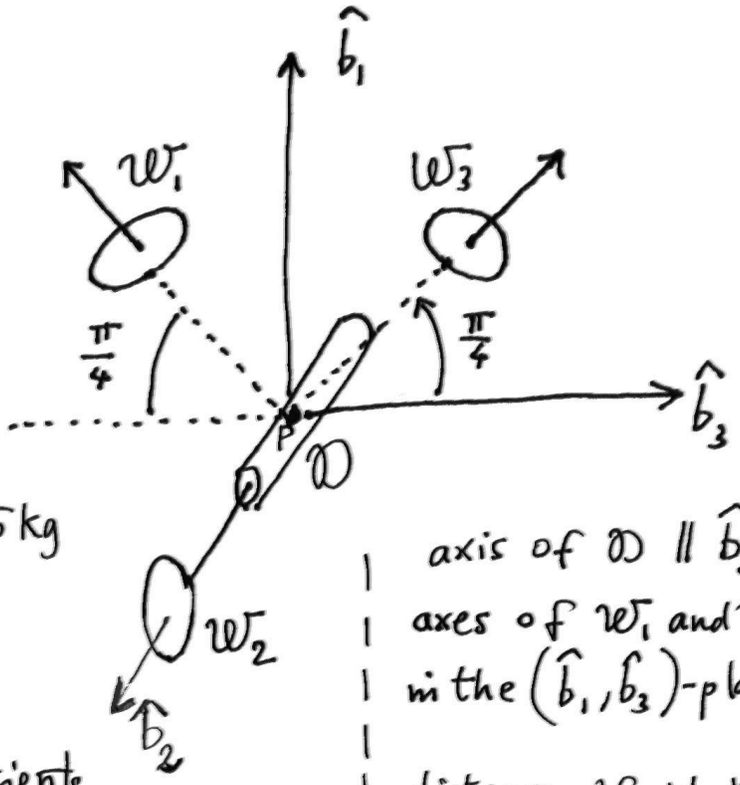
Homework 1

A spacecraft is modeled as
a rigid body $\mathcal{B}$ + damper $\mathcal{D}$
+ 3 wheels $\mathcal{W}_1, \mathcal{W}_2, \mathcal{W}_3$



Each wheel is a flat disk
with mass $m_{W1} = m_{W2} = m_{W3} = 5\,kg$
and radius $R = 1\,m$

$\mathcal{D}$ has rest point at P and
mass $m_D = 10\,kg$ and coefficients
$K_d = 5.5\ \frac{kg}{sec^2}$ $\quad C_d = 30\ \frac{kg}{sec}$

axis of $\mathcal{D} \parallel \hat{b}_2$
axes of $\mathcal{W}_1$ and $\mathcal{W}_3$
in the $(\hat{b}_1, \hat{b}_3)$-plane
distance of W_1, W_2, W_3
from P is
$b_w = 2\,m$

$\mathcal{B}$ has inertia matrix $J^{(B)}_{B,P} = \begin{bmatrix} J_1 & 0 & 0 \\ 0 & J_2 & 0 \\ 0 & 0 & J_3 \end{bmatrix}$
and mass $m_B = 100\,kg$

$J_1 = 350\ kg\,m^2$ $\quad J_3 = 400\ kg\,m^2$
$J_2 = 300\ kg\,m^2$

The 3 wheels are either

(a) rotating with constant angular velocity ω_{si} (i.e. the initial value)

(b) subject to viscous damping, with $K_W = 0.1\ \frac{kg\,m^2}{sec}$

2 cases are considered, with propagation time of 30 minutes

(1) $\mathcal{W}_1$ and $\mathcal{W}_3$ set to (a), $\mathcal{W}_2$ set to (b)

(2) $\mathcal{W}_1, \mathcal{W}_2, \mathcal{W}_3$ set to (b)

Initial conditions for (1) and (2) are

$\underline{\omega}^T(0) = [36 \quad 3 \quad 3]^T\ \frac{deg}{sec}$ $\quad \omega_{s1}(0) = \omega_{s3}(0) = 720\ \frac{deg}{sec}$; $\omega_{s2}(0) = 60\ \frac{deg}{sec}$

$\xi(0) = 0$ $\quad \dot{\xi}(0) = 0$ $\quad \underline{r}^T(0) = [0 \quad 0 \quad 0]^T$

Portray the time histories ($\in [0, 30]\,min$) of

(i) components of $\underline{\omega}(t)$ (ii) $\omega_{si}(t)$, $i = 1,2,3$ (iii) $\xi(t)$ and $\dot{\xi}(t)$ (iv) Mechanical energy

for cases (1) and (2) and comment on them