# Homework 4

## Instructions

1) You are free to discuss the questions with your classmates, but if I notice the same answer is copied all the copiers will get "0" for that question.
2) I prefer typed reports (MS Word, LaTeX etc.) Please be consistent in notations. You can use the following notations:
   - lower case bold for vector ($\boldsymbol{q} = [0 \quad 0 \quad 0 \quad 1]^T$)
   - lower case regular for scalar ($q_1$),
   - capital letter for matrix ($C$)
   - lower case right subscript/superscript for the reference frame notations ($C_{ab}$, $\boldsymbol{\omega}_{ab}^{b}$).
3) Provide the algorithms that you coded in the submitted package.
4) Due date is 25th December (Sunday) until the midnight (23:59).
5) Submit your reports on ODTUClass.
6) Title of your report file (or zipped package) should be: AE486_2022_Name_Surname_HW4

## Questions

1) (**40pts**) You are going to use the magnetic B-dot control law (refer to the lecture notes or Fundamentals of S/C Attitude Determination and Control by Markley and Crassidis, § 7.5.1) to de-tumble a spacecraft.
   Use the MOI tensor of

$$J = \begin{bmatrix} 6.9 & 0 & 0 \\ 0 & 7.5 & 0 \\ 0 & 0 & 8.4 \end{bmatrix} \text{kgm}^2$$

   which is for a satellite appoximately the size of RASAT.
   You can use the shared data with your previous homeworks to get the magnetic field in body frame. The inital quaternion is given by $\boldsymbol{q}(0) = \sqrt{2}/2[1 \quad 0 \quad 0 \quad 1]^T$ and the initial angular velocity is given by $\boldsymbol{\omega}_{bi}^{b}(0) = [0.1 \quad 0.1 \quad 0.1]^T$ rad/s. Give the angular velocity components vs. time and the dipole moment vs time plots.

   What happens if you set a limit for maximum magnetic moment (same for all three axes) as $\pm 3\text{A} \cdot \text{m}^2$?

2) (**60pts**) For the same satellite in Q1, this time you are going to control the attitude using the reaction wheels. The initial conditions are given as $\boldsymbol{q}(0) = [0.6853 \quad 0.6953 \quad 0.1531 \quad 0.1531]^T$ for quaternions and $\boldsymbol{\omega}_{bi}^{b}(0) = [0.53 \quad 0.53 \quad 0.053]^T$ deg/s for angular velocities (be careful, angular velocity terms

are in deg/s this time). The desired quaternion is the identity quaternion. The intial wheel angular momentum is set as $\boldsymbol{h}(0) = 0$ in all three axes.

Use the control laws of Eq.7.7 and Eq.7.12 from Fundamentals of S/C Attitude Determination and Control by Markley and Crassidis, § 7.2. Observe if there is any difference in the response of the spacecraft in terms of quaternions and angular velocities.

Plot also the wheel angular momentum for 4 RWs on the spacecraft if the distribution matrix is given as

$$W_4 = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & -1 \end{bmatrix}$$

Use the pseidoinverse law to get the inverse of the distribution matrix.

Good luck!
H.E. Soken