

## Homework 4

AE 402 – Fall 2021

Due: Tuesday, December 7, 2021 @ 11pm CT

Starred problem (\*) to be complete by 4-credit students only.

Round all answers to 3 decimal places and type into Gradescope. Upload all figures and code into Gradescope.

### Problem 1

Given:

$$\mu_{\text{Earth}} = 398600 \text{ km}^3/\text{s}^2$$

$$a = 7000 \text{ km}$$

$$e = 0.05$$

$$i = 35^\circ$$

$$\Omega = 100^\circ$$

$$\omega = 30^\circ$$

$$M = 0^\circ$$

- (a) Use your code from HW 2, convert the orbit elements above into to Cartesian position and velocity.
- (b) Then use a numerical integrator (e.g. ode45 in MATLAB with tolerances set to  $1 \times 10^{-10}$ ) to propagate the Cartesian initial conditions (*computed above*) for 10 orbit periods around the Earth using the perturbed two-body equations of motion where the perturbation is due to  $J_2$ .
- (c) Plot the resulting orbit.
- (d) At each time step compute and plot the corresponding orbital elements (i.e.  $a, e, i, \Omega, \omega$ ). See lecture 21, slide 16.
- (e) Which elements exhibit secular drift, which elements exhibit short period variations.
- (f) **\*Approximately what value of inclination causes  $\Omega$  to precess (opposite of regress) at about  $1^\circ/\text{day}$ ? This is known as a sun synchronous orbit (4 credit problem).**