

MAE180 Orbital Mechanics (Spacecraft GN&C)
Assignment 3
Due 9pm, Sunday, 10 Nov.

Note: You must show all your work in order to get credit.

Problems to hand in. (Not all problems may be graded.)

Complete list of problems.

1. (7 points) Suppose that an object is located at (29700, 0, 29700) km in the ECI coordinate system. What is the location of that object in the perifocal coordinate system corresponding to angles $\Omega = -\pi/6$, $i = \pi/3$ and $\omega = \pi/4$?
2. (3 points) Suppose that an object is located at (29700, 0, 29700) km a perifocal coordinate system corresponding to angles $\Omega = -\pi/6$, $i = \pi/3$ and $\omega = \pi/4$? What is the location of that object in the ECI coordinate system?
3. (10 points) Let a spacecraft be in elliptical orbit around Mars. Let the orbital elements, relative to a Mars-centered inertial (MCI) system, be

$$a = 6000 \text{ km}, \quad e = 0.3, \quad i = \frac{\pi}{6} \text{ radians},$$

$$\Omega = \frac{\pi}{3} \text{ radians}, \quad \omega = \frac{\pi}{4} \text{ radians and } \tau = 2\text{PM PST (Earth time),}$$

where we recall that τ is the time of periapsis passage. What are the position and velocity of the vehicle (in the Mars-centered inertial system) 2 hours later?

You must include all your rotation matrices in the solution for full credit.

4. (15) Suppose our spacecraft has just launched from Mars, and at the time of orbit insertion (engine cut-off), its position and velocity in an MCI system are given by

$$\vec{r}(0) = \begin{pmatrix} 819 \\ -3338 \\ -473 \end{pmatrix} \quad \text{and} \quad \vec{v}(0) = \begin{pmatrix} 3.400 \\ 0.994 \\ -1.962 \end{pmatrix},$$

in kilometers and kilometers per second, respectively, and (clearly) we have set our clock such that this is $t = 0$. Determine a, e, i, Ω, ω

and $\nu(0)$. Determine τ . Also, is the spacecraft currently in danger of crashing back into the surface of the planet if there is no trajectory correction?

5. (10 points) Suppose that an object is located at $(8000, -4000, 3000)$ km in the ECI coordinate system at 1AM PST. Suppose the ECI and ECEF coordinate systems were aligned at midnight. What is the location of that object in the ECEF system (at 1AM PST)?