

Satellite Geodesy

Homework 1

1. Given a satellite's position and velocity at epoch t_0 in the Conventional Inertial System (CIS) as follows:

$$\begin{aligned}x &= -7856125.132570323 \text{ m} \\y &= -3153615.476193391 \\z &= -8815677.901873229 \\\dot{x} &= 2296.291456475990 \text{ ms}^{-1} \\\dot{y} &= 3944.771956823101 \\\dot{z} &= -3449.641080085869\end{aligned}$$

Please use numerical integration to compute this satellite's positions and velocities over **24** hours, starting from $t_0 = 0^{\text{h}}$ UT on January 1 (initial epoch), using the following GRS80 constants:

$$GM = 3.986005 \times 10^{14} \text{ m}^3 \text{ s}^{-2}, \quad a_e = 6378137 \text{ m}.$$

Output your computational results at 1-hr interval in the format of $(t, x, y, z, \dot{x}, \dot{y}, \dot{z})$.

2. Refer to Sec. 3.2.2.3, equations (3.129)-(3.131) for the computation of acceleration vector $(\ddot{x}, \ddot{y}, \ddot{z})$ with the central (Keplerian) term and the zonal geopotential coefficient J_2 .
3. Refer to Sec. 3.3.2.2 for numerical orbit integration and determination of the *satellite state* $(x, y, z, \dot{x}, \dot{y}, \dot{z})$.
4. You can use any *language* and *integration method* of your choice, although *Matlab* and the *Runge Kutta method* are recommended.
5. To get the correct answer, you will need to re-calculate the acceleration vector at every integration step (with a step-size h).
6. The goals of this homework are (1) to compute the satellite's orbits, and (2) to evaluate the effect of J_2 (Earth's oblateness) on this particular satellite.
7. Grading is based on the correctness (partial correct values in next page) and completeness of your report, so please be thorough.

Output example (correct values) in m and m/s

0 h	-7856125.132570	2296.291456
	-3153615.476193	3944.771957
	-8815677.901873	-3449.641080

1 h	5755031.696944	3399.730706
	8754204.804534	1044.813888
	-6377968.551538	4456.737814

2 h	6750033.719893	-2966.160665
	1390833.072660	-4129.525473
	10210899.040342	2522.921916

3 h	-7005107.829396	-2819.934307
	-9017018.941616	-239.596487
	4482654.791563	-4949.617196

4 h	-5263070.117739	3559.071884
	448913.238516	4208.814790
	-11020866.890861	-1532.591175

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24 h