Advanced Orbital Mechanics: Homework #2

Deadline: 14 Farvardin 1402

Instructor: Dr. Maryam Kiani

(20 Points) Problem 1

Consider a spacecraft at the position of $\vec{r}_{km} = 6789\vec{I} + 6893\vec{J} + 7035\vec{K}$ in the ITRF coordination system.

a) (10 Points) Find the following variables(Latitude and Longitude): $\phi_{gd}, \lambda, h_{ellp}$
HINT: Use algorithm 12 of Valado's book. Two iterations would be enough.

b) (10 Points) If the observation was at 2^{nd} of May, at $00:00:00$ UT, find the position vector in the GCRF coordination system.

c) (5 Points) For April 30, 2023, 14:30:00 UT at 37° East Longitude, find the $GMST(\theta_{GMST})$ and $LST(\theta_{LST})$

(15 Points) Problem 2

A satellite has the position of $\vec{r}_{km} = -346\vec{I} + 8265\vec{J} + 4680\vec{K}$ and velocity of $\vec{v}_{km/s} = -5.657\vec{I} + -1.73\vec{J} + 2.703\vec{K}$ in ECI coordination system.

a) (5 Points) Find the position and velocity in the orbital x-y plane.

b) (10 Points) Find the position after 30 minutes in the x-y plane.

(15 Points) Problem 3

A satellite has the position of $\vec{r}_{km} = -346\vec{I} + 8265\vec{J} + 4680\vec{K}$ at August 1, 2023, 15:00:00 UTC.

a) (5 Points) Find the $\vec{r}_{sun}$ at that time.
HINT: Use algorithm 29 of Valado's book.

b) (10 Points) Check if the satellite has a clear view of the Sun (If the satellite is in shadow of the earth or not and if yes, what type of shadow).
HINT: Use algorithm 34 of Valado's book.

(50 Points) Problem 4 (Computer Based)

ISS spacecraft observation is recorded at table 1. This observation was in the first day of Spring when the ITRF and GCRF coordination systems are aligned. A ground station in Los Angeles with Latitude and Longitude shown on table 2 is trying to observe the ISS.

a) (10 Points) Simulate ISS in GCRF for 48 hours and plot the position of the ISS in the GCRF coordination system.

b) (20 Points) Simulate ISS in ITRF for 48 hours and plot the position of the ISS in the ITRF coordination system.

c) (20 Points) For 48 hours, draw a plot which indicates when the ground station can see the ISS.

d) (Bonus)(+25 Points) Find a better position for the ground station to have more view time for that 48 hours.

Hint: you can use the following package, which has been created by the author of the reference of this course. https://celestrak.org/software/vallado-sw.php, Also, this package could be useful. A lot of the transformations are already implemented in these two pages which you can use.

Orbital Element	Value
Eccentricity	0.0005771
Inclination	$51.6409_\circ$
Perigee Height	$415km$
Apogee Height	$423km$
RAAN	$88.8414_\circ$
Argument of Perigee	$75.2083_\circ$
True Anomaly	0

Table 1: ISS Observation

Latitude	Longitude
34°13'28.9"N	118°03'26.3"W

Table 2: Ground Station Location

Rules

- Homeworks should be email to alavi_hassan@yahoo.com.
- Email's subject should follow this format:

  AOM HW1 - Student Number - Student Last Name

- Email should contain a zip file containing:
  - A pdf file containing the theoretical solutions.
  - A pdf file containing the computer-based results and reports (Could be combined with the previous file).
  - A folder containing all of the codes.
- Every student is allowed to deliver the homeworks with 10 days in total without penalty (During the semester).
- Every day delay would deduct 5 percent from the total score.
- After 10 days, homeworks would be accepted but at maximum, 50 percent of the score could be achieved.