Advanced Orbital Mechanics: Homework #3

Deadline: 29 Ordibehesht 1402

Instructor: Dr. Maryam Kiani

(20 points) Problem 1

Considering Gauss planetary equation in classical variables, answer the following questions. Prove your statements.

a) (5 points) Can we change a by applying an external force such that no other elements be changed? If not, which ones will change?

b) (5 points) Can we change i by applying an external force such that no other elements be changed? If not, which ones will change?

c) (5 points) Which direction is best for applying the external forces to change a of an elliptic orbit? (R,S or W) In which θ do we gain the maximum result?

d) (5 points) For changing i of an elliptic orbit, in which θ do we gain the maximum result? What about Ω?

(40 points) Problem 2

Consider a satellite with the properties represented in Table 1 and Table 2.

Parameter	Unit	Value
a	km	6783.34174
e	-	0.0014021
i	deg	51.27632
ω	deg	90.69731
Ω	deg	275.17058
θ	deg	309.67626

Table 1: Initial Orbital Elements of the Satellite

Model the following perturbations using the fourth-order Runge-Kutta method to integrate from Gauss planetary equations. For each part, plot the orbital elements versus time which are resulted from the integration. You can also use Gauss planetary equation in modified equinoctial orbital elements. Consider

Parameter	Unit	Value
Mass	km	250
Drag Coefficient	-	2.2
Section Area	m^2	1.25
Reflection Coefficient	-	1.7

Table 2: Structural and Geometric Properties of the Satellite

noon in GMT of 04/30/2022 for the sun and the moon unit vector simulation. For parts c and d, if you think it is hard to simulate using this method, use the conventional form. (integrating from Cartesian variables).

a) J_2 perturbation.(5 points)

b) Drag perturbation. (10 points)

c) Moon third body perturbation. (10 points)

d) Sun third body perturbation. (10 points)

e) Solar radiation perturbation. (5 points)

(40 points) Problem 3

Consider the ISS from problem 4 of HW2. The ISS initial state is described in table 3.

a) Add J_2 perturbation to the simulation and plot the satellite's position in the GCRF coordination system. (20 points)

b) Do the simulation without perturbation too and, plot the distance between that and the perturb simulation in the previous part. (20 points)

c) If the maximum allowable deviation from the nominal orbit (the orbit without any perturbation) is 180 m, approximately, how long after the initial state mentioned in 3 should the ISS perform a correction manuever. (10 points)

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 3: ISS Observation

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.