Advanced Orbital Mechanics: Homework #1

Deadline: 20 Esfand 1401

Instructor: Dr. Maryam Kiani

Problem 1

Consider a spacecraft in a circular orbit around Earth with an altitude of 200 km. The gravitational parameter of Earth is 3.986×10^{14} m^3/s^2.

a) Calculate the period and angular velocity of the spacecraft's orbit.

b) Suppose that the spacecraft's velocity is increased by 500 m/s in the direction of motion. Calculate the new altitude, period, and angular velocity of the spacecraft's orbit.

c) Using the concept of the universal variable, find the time of flight and position and velocity vectors at the end of the flight if the spacecraft is given a delta-v of 2000 m/s in the direction perpendicular to the velocity vector.

d) Now consider that the spacecraft's orbit is no longer circular, but instead has an eccentricity of 0.1. Using the universal variable, find the time of flight and position and velocity vectors at the end of the flight if the spacecraft is given a delta-v of 2000 m/s in the direction perpendicular to the velocity vector.

Problem 2 (Computer Based)

Write a function to describe the n-body problem. The input to this function should be the positions and velocities of the bodies, and the output should be the derivatives of the inputs. Use ODE45 solver to simulate the following scenario. (You can use matlab for simulation. Here is a guide for ODE45 in matlab.) Select an elliptical random orbit in LEO range.

- Simulate your orbit for 1 day (draw the position in ECI frame in a 3D chart).
- Draw the ground track of your orbit.
- (Bonus) By keeping all of the orbital elements the same and just changing the inclination, observe the effect of inclination on the ground track.

HINT: It is better to create a function that takes orbital elements as input and return r and v vectors as output. By using this approach, you could use the output of the function as the initial condition for your nbody problem,

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.