AERSP-450-Fall 2024 *Problem Set - 3* Due Date: Oct. 22, 2024.

This assignment is based on material covered in class in Module M. Refer to the syllabus to see the textbook chapters associated with this HW

Please also note the general rules for this HW:

1) Your HW report must be self-contained. Ensure all steps and values are included in the report, not just in your code. We won't run your code to verify your results; everything needed should be in the report itself.
2) Similar to HW 1: You will need to include your code with all the MATLAB formatting.
3) Feel free to use your favorite method to plot the orbits in this HW.

I. Objective

The objective of this homework is to evaluate the accuracy of the Gibbs method for estimating the velocity at the middle point of a set of observations.

II. Description

The input data is provided in the following format:

- Three .mat files. Rtrue, Rmeas, tvect and V2true. These contain the True observations, corrupted observations, observation times and true velocity at the middle observation. Each of these files contains the data above for three Cases.

You are to evaluate the performance (accuracy) of the Gibbs method as a function of the time span of observations for each Case. You will be estimating the velocity at the middle point, i.e. observation 4, using the Gibbs method over different time spans. The process is

1) Using the position observations 3, 4 and 5 using the Gibbs method compute the velocity at the time of observation 4.
2) Compute the error in the velocity estimate, that is

$$\delta v = \left[(\dot{x}_{gibbs} - \dot{x}_{true})^2 + (\dot{y}_{gibbs} - \dot{y}_{true})^2 + (\dot{z}_{gibbs} - \dot{z}_{true})^2\right]^{1/2}$$

3) Now use observations 2, 4 and 6 and repeat the process of step 2.
4) Next use observations 1,4 and 7 and repeat the process of step 2.
5) Do this for both the perfect observations and the corrupted observations. Provide your results in a Table like the one below.

A. Software Validation

You will need to write Software for the Gibbs methods. You have been given perfect observations and the velocity at the time of middle observation. The Gibbs method is a Taylor series expansion about the mid point of the track. This means for small Δt and the perfect observations, your answer should almost match the exact answer for the velocity at the middle observation, i.e., observation #4. Use this fact to validate your Software.

Obs	Perfect obs			Corrupted obs		
	Est vel	δv	% error	*Est vel*	δv	% error
3,4,5						
2,4,6						
1,4,7						

Fig. 1. Case 1 / 2 / 3

B. Observations

The corrupted measurements were created by adding a noise equivalent of 10 meters to each component of the position measurements.

1) For cases 1, 2, 3, what is the true-anomaly difference between the measurements.
2) What can you comment on the efficiency of the Gibbs method ? You may use the table or additional plots to justify your answer.
3) Under what observation conditions (observations Far apart or close-by) would you prefer to use the Gibbs Method.
4) What are the orbital elements of the observed orbit?