ME 594
Homework 3

Work the following problems, SHOWING ALL OF YOUR WORK. This includes writing the proper equation(s), inserting the proper value(s), & calculating the final answer(s). If you utilize MATLAB or similar software, you may attach code and/or command line output to supplement your written work. Include the following statement at the top of your assignment:

"I ATTEST THAT I HAVE NEITHER GIVEN NOR RECEIVED HELP (other than from the instructor) ON THIS ASSIGNMENT."

1. In this assignment, you will investigate the effect of perturbation forces on the motion of an Earth-orbiting satellite. Begin by choosing a set of orbit conditions for your satellite (i.e. values for the six orbit elements) along with an arbitrarily chosen epoch time t_0. Here is the recommended way to proceed:

- Convert your orbit element values into a position and velocity vector using the method in the textbook and propagate the 2-body equations of motion (ODEs) from t_0 to a time t_f that you select. This propagation will yield a history of the satellite's position and velocity components ("r-bar" and "v-bar") at numerous time steps from t_0 to t_f. (Note that you also propagated in this fashion for the Midterm assignment.)
- At each time step, convert position and velocity into orbit elements; you will then have a history of your spacecraft's orbit elements from t_0 to t_f based on two-body motion.

Now choose one of the perturbation forces covered in this week's lecture and perform the above steps given the same initial orbit conditions, but now including the perturbation component in your ODEs. The result will be a history of your spacecraft's orbit elements from t_0 to t_f based on perturbed motion. Characterize the difference between the perturbed and unperturbed motion in whatever way you feel best conveys those differences. This may include (but is not limited to):

- plotting the time history of each orbit element (e.g. plot a vs. t, e vs. t, etc), overlaying the perturbed and unperturbed values
- displaying a table of the perturbed and unperturbed orbit elements at selected times during the trajectory, perhaps to show the maximum changes caused by the perturbation
- plotting the trajectory in either 2D (planar) or 3D (x vs. y vs. z)

2. Choose a second perturbation force and incorporate that into your ODEs instead of the perturbation chosen above. Repeat the above steps, including adequate output to illustrate the effect of this perturbation on your satellite's motion. Finally, comment on the different effects of the two perturbations on your satellite's motion. Is this result consistent with the chart on the last slide of this week's lecture?

Here are some points to keep in mind:

- Assume $\mu = 3.986 \times 10^5$ km^3/sec^2. For parameters pertaining to the perturbation (ρ, C_D, A, m, Φ, etc), you may choose reasonable values based on your understanding of them.

- Your propagation time may vary, depending on how long you feel you need to propagate in order to show the effect of the perturbation force. If you choose drag as your perturbation, this will take a fairly long time to cause appreciable changes to your orbit. You will want to experiment with different values of propagation time, ranging from one to several days or even longer. You might choose an intentionally large value of ballistic coefficient ($C_D A/m$) for your satellite so that drag's effect on the orbit will be quicker.
- If you choose J2, you will be looking for the secular and periodic fluctuations in the orbit elements outlined in lecture.