EAS 4510

HW 2

Spring 2017

Due 16 March 2017, 11:59pm

What Allowed During Examination/HW

You may use any books, your personal notes, or electronic aid, provided that you find the material on your own without having it provided to you by anyone else (either implicitly or explicitly). **You may not, under any circumstances, communicate with anyone about this exam/hw, and that includes me and TAs!**

Any violations of the exam/hw rules will result in further action on my part in a manner consistent with the academic honesty policy of the University of Florida. The academic honesty policy can be found at the Student Conduct and Conflict Resolution website:
https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/

Guidelines for Solutions

Communication is an extremely important part of demonstrating that you understand the material. To this end, the following guidelines are in effect for all problems on the examination/hw:

1. Your handwriting must be neat. I will not try to decipher sloppy handwriting and will assume that something is incorrect if I am unable to read your handwriting.

2. **ONLY FOR IN-CLASS TESTS**: your test must be HANDWRITTEN, no software, no scans, etc., your own handwriting ONLY. If anything else appears other than your own handwriting, the test will be evaluated at 0 (zero).

3. You must be crystal clear with every step of your solution. In other words, any step in a derivation or statement you write must be unambiguous (i.e., have one and only one meaning). If it is ambiguous as to what you mean in a step, then I will assume the step is incorrect.

4. Tests without name on each page, and/or without UFID and signature at the bottom of this page, will not be graded, i.e., they will count as a 0 (zero).

5. ANY assignment (HW, exam, etc.) without signature, date, and UFID at the bottom of this page, will not be graded (i.e., they will receive a score of 0 (zero)).

In short, please write your solutions in an orderly fashion so that somebody else can make sense of what you are doing and saying. Finally, credit will be given only if a relevant concept is applied properly, and no credit will be given for an incorrectly applied concept even if the final answer is correct.

University of Florida Honor Code (only for HW)

On your exam/hw you must state and sign the University of Florida honor pledge as follows:
On my honor, I have neither given nor received unauthorized aid in doing this examination/hw.

Signature: **Date:**

University of Florida ID:

Total points: 100

The following requires you to turn in working MATLAB file(s) (i.e., *.m files, no other extensions) that we can run without error. Files should output all required quantities and/or plots. Upload your MATLAB files and additional scanned papers (e.g.: previous page signed) on Canvas, within the deadline. If any required function is missing and/or the files are not *.m, the HW will be returned without grading, and the score will be a zero (0). Neither the TAs or myself will copy-paste from files and/or use functions that you do not include in the deliverable, no matter if those functions are posted on the website or canvas.

The following also requires you to turn in an entire working scenario in STK – STRONGLY SUGGESTED: zip the folder where the scenario is saved, and submit it. The same philosophy outlined above for Matlab files is valid for STK files.

The International Space Station (ISS) has the following orbital parameters on March 3rd, 2017 at 12:00:00 Greenwich Mean Time (GMT) [from now on this time will be called the "Epoch"]:

a = 6778.92817 km
e = 0. 0008446
i =51.46843 deg
Ω= 203.98784 deg
ω= 141.71208 deg
θ = 149.88842 deg

1) Convert the orbital parameters at the Epoch into Cartesian Coordinates in ECI (state vector) **[10 pts]**
2) Integrate, with ODE45, the ISS orbit for 6 hours, starting from the above computed state vector as initial condition, using the *relacc_with_j2.m* function, and a maximum time step of 10 seconds. Plot the orbit in 3D **[10 pts]**
3) At each time step generated by ODE45, convert the state vector into orbital elements **[10 pts]** **SUGGESTION:** create a function taking state vector and outputting orbital elements. Do a *for* loop around that function.
4) Plot each orbital parameter, except true anomaly, as function of time, with time in hours, and angles in degrees **[10 pts]**
5) From the state vector, compute the spacecraft's latitude and longitude on the Earth (ground track), appropriately correcting the longitude to take into account the Earth's rotation. The functions to use are:
    a. *juliandate.m* to convert the Epoch into Julian Date;
    b. *gstime.m* to compute the longitude, in ECI, of Greenwich's Meridian at the Epoch.

    Use angular velocity of the Earth about its axis to be $72.9217*10^{-6}$ rad/s.

    HINT: the Greenwich Meridian's longitude in ECI at the Epoch gives the correction only at the Epoch! At each time step after the Epoch, the rotation of the Earth adds to the initial longitude in ECI of the Greenwich Meridian.
    [10 pts]

6) Make sure the above computed latitude and longitude are in the ranges -90 to 90 deg for latitude and 0 to 360 deg for longitude (look into the *mod* function in Matlab) **[10 pts]**
7) Plots the ISS ground track in the Mercator plane (East longitude vs latitude) – remove line in plot and use dot markers **[10 pts]**

8) Use the last time step's orbital parameters for the ISS as initial condition in STK's Astrogator to solve for a Hohmann transfer to a circular orbit of altitude 1,000 km. Use J2 propagators and start the maneuver 1000 seconds after of the above-mentioned last time step. Also, use radius of the Earth as 6,378 km, max step of 0.1 km/sec and tolerance of 0.1 km on apoapsis and 0.1 on eccentricity in the differential correctors. Propagate the obtained final orbit for 10,000 seconds. Use yellow, green, and red, in this chronological order, for the propagate segments to visualize the trajectories in 3D **[total 30 points, broken up as:]**

   a. Correct setup of initial conditions in Astrogator [**5 pts**]
   b. Correct choice of start time for the first burn [**5 pts**]
   c. Correct choice of propagators for "propagate" segments [**5 pts**]
   d. Correct setup of differential targeters for the maneuvers and their correctors [**5 pts (2.5 each)**]
   e. Correct deltaVs computed [**5 pts (2.5 each)**]
   f. Correct visualization in 3D with required colors and duration of last "propagate" [**5 pts**]

   HINT: Do not re-invent the wheel! Look at the Astrogator example completed in class and the related link on STK website.