ASEN 5050 – Spring 2021

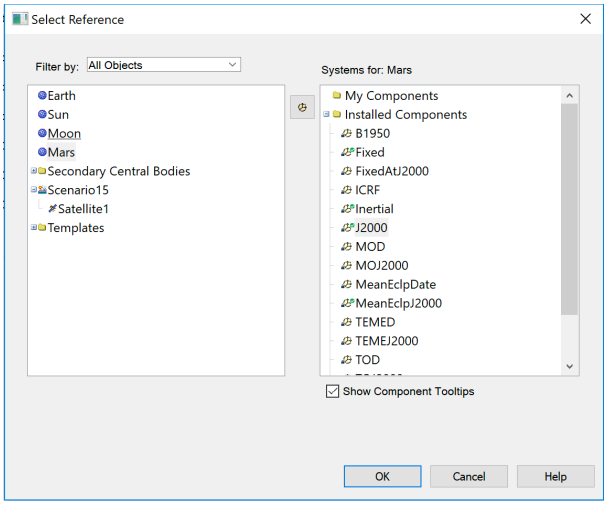
HW 5 Supplement – STK Instructions

Complete these instructions to answer questions in HW 5

For this set of instructions, you will be provided with fewer fundamental steps in constructing a scenario, requiring you to have completed the previous STK instructions. If you used a different software package for the previous homework, please reference the earlier STK instructions.

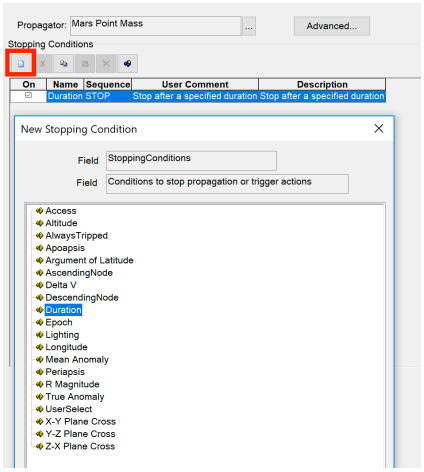
In this problem, you will model the motion of a spacecraft around Mars. In the process, you will learn to change the stopping conditions during integration to visualize different arcs along an orbit.

1. Open STK. In the top menu bar, click "View" and then "Planetary Options". Then, create a new mission scenario. Select a name for the scenario, then set the "Start Date" as "1 Apr 2015 00:00:00.000 UTCG". Set the "Stop Date" for the scenario one year later. Set the "Central Body" to "Mars" via the drop-down menu (this will save you a lot of time in configuring the scenario!). Then, click OK to create the scenario.
2. Create a new propagator that models the point mass gravitational contribution of Mars: Navigate to "Utilities"→ "Component Browser". Under the "Propagators" folder, duplicate the "Earth Point Mass" propagator. Rename it to "Mars Point Mass" and configure it by changing the "Central Body" to "Mars". Record the value of the gravitational parameter used by STK for Mars.
3. Insert a satellite in orbit about Mars, ensuring that the central body is set to Mars when creating the object. Open the Satellite properties window to configure the spacecraft. First, set the "Propagator" to "Astrogator". You should see the mission sequence appear.
4. Ensuring that the "Initial State" segment is highlighted, configure the initial conditions. Set the Coordinate System. To do this, click the "…" next to the default Coord. System option. You should see a properties window that resembles the following image:



5. On the lefthand panel, ensure that "Mars" is highlighted, while on the righthand panel, ensure that "J2000" is selected.

6. Then, set the “Coordinate Type” to “Keplerian”. Set the initial conditions to the following:
    i. a = 6600 km
    ii. e = 0.46
    iii. Inc = 74.2 deg
    iv. RAAN = 207 deg
    v. AOP = 10 deg
    vi. TA = 180 deg
7. Next, customize the “Propagate” segment in the mission sequence. Change the “Propagator” to the “Mars Point Mass” propagator you created earlier. Then, set the propagator to continue only until the spacecraft reaches an altitude of 500 km. To enforce this stopping condition, add a new stopping condition by clicking the blank page icon above the list, as indicated via red box in the figure below.



8. Instead of duration, select “Altitude”. Add this stopping condition, and you will see two conditions in the list. Uncheck the box next to “Duration” to disable that stopping condition. Keep the checkbox next to “Altitude” checked. Then, change the “Trip” value to 500 km and ensure that the “Central Body” is selected as “Mars”. Save your changes. Change the orbit color for this segment to blue (you will update the background later).
9. STK has useful summary features, that indicate the orbit properties at the **end** of each segment. For only the “Initial State” segment, the beginning and end of the segment are equivalent – which means that the summary function can report a large variety of characteristics for the initial state, saving you from calculating them yourself.
10. First, run the mission sequence by clicking the green arrow above the mission sequence list.
11. Next, to extract useful information from the summary feature, we must update the coordinate system of each segment to the “Mars J2000” frame – unfortunately, STK does not do this automatically. Double-click the “Initial State” segment and select for “Coord. System”, “Mars J2000” using a similar process as when you configured the orbital element description for the initial state. Click OK. Repeat this process for any additional propagate segments added during this part of the lab – right now, you should update the coordinate system for the propagate segment.

12. To use the summary feature, simply right-click the segment of interest – in this case, the initial state – and click the "Summary…" option. You will then see a window appear with text information. Before extracting any quantities of interest, always check the "State Vector in Coordinate System" value and ensure that it reads "Mars J2000". This parameter appears near the beginning of the segment summary.

Answer Questions a), b) and c) (where the "report function" in the problem statement is simply referring to the "Summary" feature).

13. Configure the three-dimensional view so that you can clearly visualize the orbit of the spacecraft. Navigate to the 3D graphics window to view the orbit in three dimensions near Mars. You may need to zoom out to view the entire orbit. To remove the Mars shadow from the 3D graphics window, navigate to the 3D graphics properties window (the yellow note icon at the left of the toolbar in your 3D graphics window) and select the "Lighting" page. Then, uncheck the "Enable Lighting" property. Click "Apply".
14. To change the background color of this picture to white (and save some ink!), select the "Details" page in the 3D graphics properties window. Under "Window Background" select the color white. Click "Apply" and then "OK".
15. The line representing the orbit is thin – let's increase the thickness. Navigate to the satellite properties window, and under the "2D graphics"→"Attributes" window, click the "More" next to the second item in the list (with a start date matching the initial epoch). Under "Graphics Attributes", increase the line width to the maximum thickness using the drop down menu. Click OK to save your changes, then "Apply" in the "2D graphics attributes" window. Run the MCS again and navigate back to the 3D graphics window to view the orbit. (Sometimes, in STK, this line width changes unexpectedly, so you may need to re-complete this step later)
16. Next, let's add two more propagate segments. Navigate to the MCS, and right-click the existing "Propagate" segment. Then click "Insert After" and select the "Propagate" segment type. Configure this propagate segment to propagate until an altitude of 500 km with respect to Mars. This will capture the component of the trajectory that corresponds to a spacecraft trajectory below 500 km. Ensure that you update the propagator to your "Mars Point Mass" model you created earlier.
17. Change the color of this segment to red by double-clicking the propagate segment and selecting from the "Color" dropdown.
18. Add a third propagate segment that integrates the spacecraft using the "True Anomaly" stopping condition, ensuring that the spacecraft motion is integrated until the true anomaly corresponding to the initial condition and relative to the correct central body (i.e., not Earth!), thereby completing the orbit. Enter the true anomaly of the initial condition in the "Trip" value once you have added and activated the "True Anomaly" stopping condition and change the central body. Ensure that you updated the propagator, and change the orbit color to dark green.
19. **Have you saved your scenario recently?**
20. Run the MCS.

    Answer Question d).