ENAE 791 - Spring, 2008
Problem Set 3

Due 4/10/08

Write a program to perform numerical integration of the planar equations of motion for a spacecraft entering the atmosphere. Include the appropriate constants for Earth. You may write this from scratch, set up a spreadsheet to perform step-by-step numerical integration, or use canned routines in Matlab such as ODE45.

1. Find the velocity for a spacecraft in a circular Earth orbit at 450 km altitude. Use these initial conditions for your numerical integration and show that it does indeed produce a circular orbit. Check the orbital period predicted by the simulation versus the calculated orbital period to verify that your simulation is correct in both position and time at the end of one orbit.

2. The Orion spacecraft has a heat shield diameter of 5 meters, a mass of 9500 kg, and the heat shield is a 65° section of a sphere (32.5° half-angle). Based on continuum Newtonian flow, calculate the drag coefficient of the heat shield (at zero angle of attack), and the ballistic coefficient for the Orion spacecraft.

3. Find the deorbit ΔV required to reach entry interface at 122 km altitude with a -2° flight path angle, starting from the orbit in (1). Calculate the velocity at entry interface.

4. Use your numerical integration routine to solve for entry trajectory assuming L/D=0.2, with the lift vector pointed upwards throughout the entry. Plot
   a. Altitude vs. downrange distance
   b. Deceleration vs. altitude
   c. Deceleration vs. time
   d. Velocity vs. time
   e. Velocity vs. altitude