ENAE 791 PROBLEM SET 2 – SPRING, 2020

DUE 3/10/20

Extend your computer routine from the first problem set to incorporate aerodynamic lift and drag and numerically integrate the planar state equations derived in class as necessary for the following problems.

(1) The Orion test flight on December 4, 2014, involved a test of the heat shield for the Orion spacecraft. The spacecraft reached an apogee *altitude* of 5800 km and reached entry interface at an altitude of 122 km. If the desired flight path angle at entry interface was -2.5^o, find the entry velocity for the spacecraft.

(2) The Orion spacecraft had a mass of 10,400 kg, a base diameter of 5 meters, and a hypersonic c_D of 1.2. Find the ballistic coefficient for the entry vehicle.

(3) Calculate the trajectory of the Orion spacecraft undergoing a ballistic entry under these conditions. Plot (a) altitude vs. velocity, (b) altitude vs. time, (c) altitude vs. downrange distance, and (d) deceleration vs. altitude for this trajectory. What is the peak deceleration? What is terminal velocity?

(4) Using the equations derived in class for an analytical approximation of ballistic entry, plot the results for (a) and (d) on the same plots as you created for (3). How do the analytical approximations and the numerical integration results compare?

(5) Repeat (3) for a lifting entry with the lift vector pointed upwards and an L/D of 0.25.