ENAE 788X PROBLEM SET 1 – FALL, 2014

REVISED 10/2/14 – DUE 10/7/14

(1) You would like to explore Earth's moon using rocket-propelled hopping vehicles.
   (a) Designers of a 5000 kg pressurized rover would like to include emergency thrusters which would let the rover jump 10 meters in case it gets stuck in some critical terrain. What Δv would this maneuver require?
   (b) Assuming the use of storable propellants with an exhaust velocity of 3100 m/sec, how much propellant would this maneuver require? Assume that 5000 kg is the initial mass of the vehicle. *If you aren't familiar with the fundamentals of the rocket equation, contact me and I'll give you a reference you can use to catch up.*
   (c) A dedicated hopping vehicle would be used for longer traverses. How much Δv would be required for a 10 km ballistic hop-style traverse?
   (d) How would the previous answer change if you used a propulsive glide instead?
   (e) How much Δv would be required to travel from the bottom to the top of a vertical cliff which is 500 m tall? Assume you start from a point 100 meters horizontally from the face of the cliff.
   (f) After creating rocket propellant from lunar resources, I want to use the landing vehicle as a long-range transport. How much Δv would be required to perform a ballistic hop of 1000 km and, after completing a science EVA there, return?

(2) You are developing aerial vehicles for use on Mars. Use the exponential equation for Mars' atmosphere as presented in class. You are designing a small (100 kg) survey drone for local exploration and mapping. You are adopting a design with an L/D=30, aspect ratio of 20, and e=0.9. Your maximum lift coefficient $c_{L_{max}} = 1.8$, and $c_{D_o} = 0.05$.
   (a) To achieve a desired stall speed of 20 m/sec at an altitude of +1 km, how large would the wing planform area S have to be? If the wing were rectangular, what would the span and chord of the wing be?
   (b) Create a drag polar plot for the vehicle in level flight at +1 km as in the chart on pg. 14 of the lecture slides. Remember that c_L at each velocity is chosen to maintain level flight.
   (c) What is the airspeed velocity that produces $(L/D)_{max}$?
   (d) What airspeed velocity corresponds to $(V \times L/D)_{max}$?