AA103 Homework 2, 2020 - 2021

Cantwell Spring 2020-21

Due April 13, 2021

Suggested Reading

https://web.stanford.edu/ cantwell/AA200_Course_Material/
AA200_Course_Notes/AA200_Ch_12_Wings_of_Finite_Span_Cantwell.pdf/

Problem 1

The figure below shows several views of the Northrup F-5/T-38 fighter/trainer aircraft used by a variety of nations since it was introduced to service in 1962. Although the aircraft can fly supersonically, the cruise speed for maximum range of the clean aircraft is $M_0 = 0.8$. The range during cruise is approximately $1800km$. Determine the altitude for minimum drag at the beginning and end of cruise. Assume 15% of fuel mass is needed to reach the cruise condition and 5% of fuel mass remains at the end of cruise. Rele-

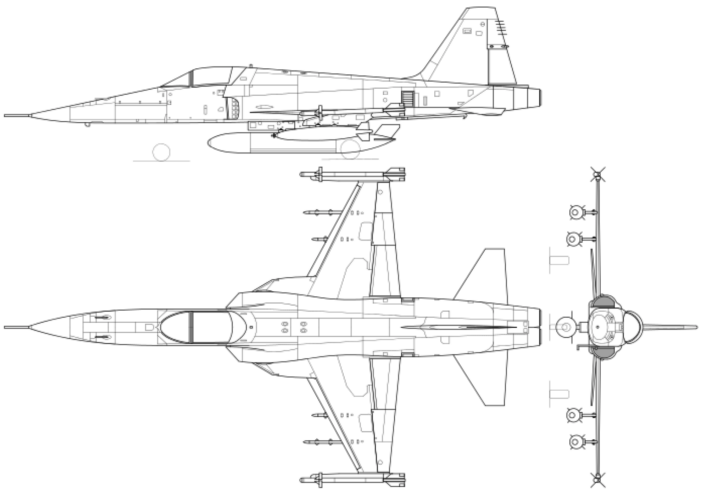

Figure 1: F-5 in several views

vant data is as follows.

a) Takeoff weight (clean aircraft, no stores, full fuel load) = 11,192 kg
b) Fuel volume = 2.56 m^3
c) Fuel density = 789.5 kg/m^3
d) Wingspan, $b = 8.13m$
e) Wing area, $S = 17.3m^2$
f) Frontal area = 0.32 m^2
g) Zero lift, profile drag coefficient, $C_{dp} = 0.012$
h) Span efficiency, $\epsilon = 0.6$

2)Determine the aircraft drag at this altitude and Mach number.

Problem 2

Yesterday, Easter Sunday, my wife and I spent the day with our daughter's family and her in-laws in Lafayette which is a town in the East Bay near Walnut Creek. At one point we decided to open a bottle of Champagne. One of our grandchildren, a high school junior and aspiring engineer, asked to to do the opening so he could shake the bottle and see how far the cork would go (I am not making this up). So the experiment proceeded and he made the following three measurements. All units are meters.
i) The coordinates of the cork release point (x, y) = (0,1.52)
ii) The angle of the bottle above the horizontal at the point of release was 25 degrees.
iii) The coordinates of the cork landing point (x, y) = (11.81,0)

Neglecting possible air drag effects, determine:
1) The trajectory of the cork connecting the initial and final points.
2) The velocity of the cork, V_{cork}, as it leaves the bottle.

Feel free to go online for whatever information you need to answer the following questions.

3) Estimate the time over which the bottle pressure acts on the cork to raise its speed to V_{cork}.
4) Determine whether neglecting air drag is justified. Estimate the Reynolds number of the flow over the cork as it leaves the bottle. Estimate the air drag on the cork as it leaves the bottle and compare it to the force of gravity. How would your estimate of the cork velocity change if you included drag?