AOE 2104 Introduction to Aerospace Engineering
Problem Sheet 5

Due 14 October, 2003

Read Performance section from web site: <www.aoe.vt.edu/~lutze/AOE2104>

21-25. A jet powered executive jet has the following properties:

b = 54.4 ft — 4 turbojet engines @ 3300 Lbs thrust @ sea level

S = 542.5 ft — $C_{D_{0L}}$ = 0.028

W = 42,000 lb — Oswald efficiency factor = 0.9

$C_{L_{max}}$ = 1.6

Assume that the thrust level is constant with changes in airspeed, and is proportional to density.

Calculation of the Level Flight Envelope

a) At sea level

i) Calculate, tabulate, and plot, the drag (lbs) (thrust required), vs. airspeed (ft./sec)

ii) Calculate, tabulate, and plot, the thrust available (lbs) vs. airspeed (ft/sec)

iii) Estimate (from the plots) the maximum and minimum thrust- limited airspeeds at this altitude (or calculate them).

iv) Calculate V_{stall} at this altitude

v) Determine the true minimum airspeed at this altitude

b) Repeat part (a) for 10,000, 20,000, 30,000, and 40,000 ft.

c) Plot on a graph with airspeed as the "x" axis and altitude as the "y" axis

i) altitude vs maximum airspeed

ii) altitude vs ***the greater*** of (stall speed, thrust-limited minimum speed)

d) Estimate the ceiling of this aircraft (You do this by "eyeballing" and smoothly joining the max and min airspeed curves, or by looking at your tables and estimating at what altitude the single solution (not two as for lower altitudes) T = D.

Note 1: These are repetitive calculations that are best done by a computer. I would suggest that you use MATLAB to do the calculations and the plots. However you can also use a spreadsheet and use its plotting capabilities, or you can do it by hand and make plots (not sketches) by hand.

Note 2: The range of velocities is not given. You should decide on that and after you complete some calculations, revise your selected range if necessary. In addition, the range of velocities for each altitude can be different. In any case, any drag value much greater than the thrust available is not needed, and if included in your calculations can cause the scales to be distorted. For example, if at sea level the thrust available is 13,200 lbs, then if at some low airspeed the drag is calculated to be 20,000 lbs, that speed should not be included on your plot, since it is not of interest, and the scale will be at least 0 to 20,000 lbs. Consequently all the points of interest will be in the bottom half of the graph, the top half just wasting space.