AOE 2104 Problem Sheet 6

Due 21 October, 2003

Read Stabilty section on <www.aoe.vt.edu/~lutze/AOE2104>

The following problems (unless otherwise indicated) are concerned with an aircraft that has the following properties:

weight W = 17,578 lbs Area S = 260 ft^2 Span b = 27.5 ft mean aero chord $\bar{c}$ = 10.8 ft

The vehicle is flying at Mach 0.8 at 35,000 ft (density = 0.0007382 slugs/ft^3 , speed of sound - 973.14 ft/sec)

26. a) Find the lift coefficient
b) Assuming that at zero angle of attack, the lift coefficient is zero, find the angle of attack for flight at this condition if $\frac{dC_L}{d\alpha} = 4.0 \text{ /rad}$ (express answer in degrees)
c) Sketch the lift coefficient vs angle of attack for this aircraft.

27. Under these flight conditions (altitude and speed), find the value of the pitch-moment coefficient if the lift were zero, that is find $C_{m_{0L}}$. Note that under these flight conditions:

$$\frac{dC_m}{d\alpha} = -0.39 \text{ /rad}$$

28. If the elevator is deflected in a negative direction (trailing edge up), in such a manner that the zero lift intercept increased by 0.01 (i.e. $C_{m_{0L}}$ was increased by 0.01):

a) What would be the new angle of attack (in deg)?
b) What would be the new equilibrium flight speed (assuming thrust adjusted so T = D)?

29. We can fly at stall speed, $C_{L_{max}} = 1.5$, in two different ways:

a) We can adjust $C_{m_{0L}}$ to maintain balance flight ($C_m = 0$), Find the value of $C_{m_{0L}}$ required to fly at stall speed.
b) We can move the center of gravity. Under this scenario, the value of $C_{m_{0L}}$ remains the same as its original value (calculated in problem 27), but the slope of the pitch curve, $\frac{dC_m}{d\alpha}$ is changed. Determine the new slope (longitudinal stability parameter) required so that the aircraft is balanced at stall speed (in units - /rad)
c) Is the aircraft more stable (more negative slope) or less stable then in the cruise condition of problem 26 if we use the CG movement method to balance the aircraft at stall?

30. You have looked at performance and plotted thrust and drag vs airspeed. The solution to the equation T = D occurs where the two lines intersect. We also know that Newton's law apply,

$\vec{F} = m\frac{d\vec{V}}{dt}$ in general an that $\vec{F}$ = 0 at those points. We will assume that thrust is independent of airspeed (T = const). Describe how drag must vary with airspeed to insure that the aircraft is ***statically stable*** with respect to velocity. Then indicate the stability status of the two reference flight conditions - thrust limited maximum airspeed, and the thrust limited minimum airspeed.

(You folks are on your own on this one - I will only answer questions on clarity of the problem, not how to do it)