Problem Sheet 1
AOE 3134 Stability and Control

Due: 29 January, 2002

Read: Chapter 1, 1.1- 1.3, 1.6
Chapter 2, 2.1 - 2.3

1. Wind tunnel tests yield the following data:

When $C_L = 0.2$, $C_{m_{0.25}} = -0.040$, and when $C_L = 0.6$, $C_{m_{0.25}} = -0.036$.

Find:

a) h_{n_w}

b) $C_{m_{ac}}$

c) h_{cp} when $C_L = 0.5$

d) Is this vehicle a candidate for a flying wing? Why or why not?

2. A wing has the following aerodynamic properties:

$C_{m_{ac}} = -0.04$ $C_{L_\alpha} = 0.08\ /deg$ $h_{cg} = 0.3$ $\alpha_{0L} = -2.0$ deg

$W_{wing} = 50$ lbs. $S = 5$ ft^2 $\bar{c} = 1.2$ ft.

Assume that the aerodynamic center is located at the quarter chord point.

A wind tunnel (located at sea level) is designed so that the air flows vertically upward. The above wing is mounted in this wind tunnel so that the leading edge is down and the trailing edge is up. The wing is attached to the support system by a massless stiff rod attached to the leading edge that extends forward (along an extension of the wing chord). It is one chord length long and is attached to a fixed support in the wind tunnel. When the wind at some speed, the wing will come to an equilibrium position. Find:

a) The wind tunnel speed required to maintain an angle-of-attack of 5 degrees

b) Discuss how the equilibrium angle-of-attack will change with

i) Increasing the tunnel speed

ii) keeping the speed the same, but lengthening the support rod.

c) Intuition tells us that their might be two solutions (one on each side), but the equations in part (a) tell us that there is only one solution, What assumption leads to this result?

3. When the velocity is 300 ft/sec at sea level, the wing lift on an aircraft is 3000 lbs., and the center of pressure is 2.4 ft aft of the wing leading edge. If the span b= 36 ft. and the chord $\bar{c}$=6 ft., find the pitch-moment coefficient about the leading edge.

4. Consider a flying wing with $C_{m_{0L}} = 0.04$, and $C_{m_\alpha} = -0.0064\ /\text{deg}$. The wing has a wing loading (W/S) of 75 lbs/ft^2. The center of gravity is located at 30% mean aerodynamic chord, and the wing lift-curve slope is $C_{L_\alpha} = 0.08\ /\text{deg}$.Note all moments are referenced to the cg. position.

a) Find the lift coefficient required for equilibrium flight.

b) Find the lift coefficient required if the cg is moved aft to $0.5\bar{c}$. (If possible).