In the Name of Allah

1- For a given wing-body combination, the aerodynamic center lies 0.05, chord length ahead of the center of gravity. The moment coefficient about the aerodynamic center is -0.016. If the lift coefficient is 0.45, calculate the moment coefficient about the center of gravity.

2- A wing-body model is tested in a subsonic wind tunnel. The lift is found to be zero at a geometric angle of attack $= -1.5°$. At $\alpha = 5°$, the lift coefficient is measured as 0.52. Also, at $\alpha = 1.0°$ and $7.88°$, the moment coefficients about the center of gravity are measured as -0.01 and 0.05, respectively. The center of gravity is located at $0.35c$.

a) Calculate the location of the aerodynamic center and the value of $C_{M,ac_{wb}}$

b) The area and chord of the wing are $0.1\ m^2$ and $0.1\ m$, respectively. Now assume that a horizontal tail is added to this model. The distance from the airplane's center of gravity to the tail's aerodynamic center is $0.17\ m$, the tail area is $0.02\ m^2$, the tail-setting angle is $i_H = 2.7°$, the tail lift slope is 0.1 per degree, and from experimental measurement, $\varepsilon_0 = 0$ and $\partial\varepsilon/\partial\alpha = 0.35$. If $\alpha = 7.88°$, calculate $C_{M,cg}$ for the airplane model.

c) Does this model have longitudinal static stability and balance?

3- An airplane has a wing and a horizontal tail of identical platform geometry (i.e. similar aspect ratio, taper ratio, sweep angle, thickness ratio and airfoils). Assume $S_H = \frac{1}{4}S_W$. Assuming the wing has 3 degrees of dihedral, how much dihedral must the tail have to compensate for the wing dihedral effect $C_{l_{\beta_w}}$?