GATE Aerospace Engineering

Assignment – Longitudinal static stability

Q 1. Consider a chambered airfoil as shown in the figure with forces, moments etc.
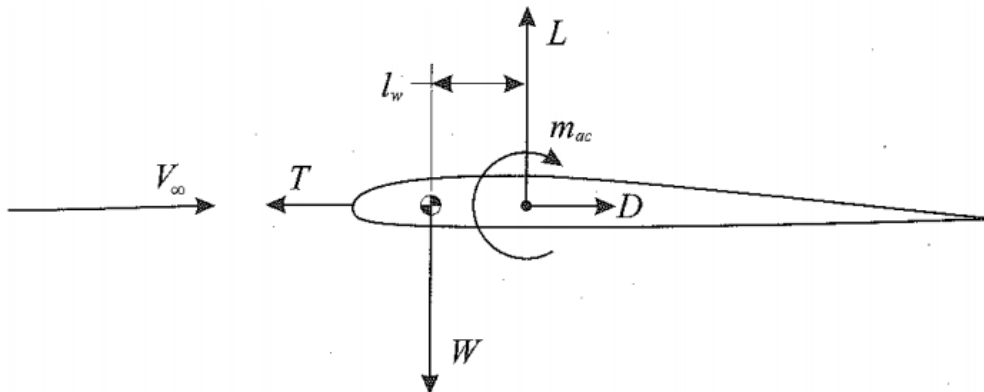
Apply force balance and moment balance and obtain the necessary condition for trim.

An aircraft has the following data.

$$\overline{x}_{cg} = 0.3, \overline{x}_{ac} = 0.24, C_{Lw} = 0.1(\alpha^0 + 2.5), C_{L,max} = 1.2$$
$$C_{macw} = 0.06, \varepsilon = 0.3\alpha, C_{mf} = 0.05 + 0.1C_L, a_t = 0.08 / deg$$
$$\eta_t = 0.9, V_t = 0.6, i_w = 0, i_t = 2\,deg, C_{h\alpha} = -0.002 / deg,$$
$$C_{h\delta e} = -0.003 / deg, \tau = 0.2$$

Q2. Find the angle of attack in the steady level flight if elevator is locked in the neutral position.

Q3. The permissible most forward position of the CG if maximum elevator deflection is limited to 30 deg.

Q4. Stick free neutral point and stick free static margin.

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Consider a wing tail configuration with the following properties

Area of wing = 180 ft^2

Span of wing = 33 ft.

Lift curve slope of wing = 4.44

Zero lift angle of wing = -2.2^0

Coefficient of moment at the aerodynamic center of wing is -0.053

Area of horizontal tail = 36 ft^2

Span of tail = 12 ft.

Lift curve slope of tail = 3.97

Distance between the aerodynamic center of wing and tail is 15 ft

The downwash angle for the tail is 2.315^0 and the rate of change of downwash angle w.r.t AOA is 0.44

The and tail are mounted in such a way that at an airspeed of 120 mph at standard sea level condition, trim is attained with no lift on horizontal tail and zero AOA. (Assume any parameter if not given)

Obtain the following

Q5. Location of cg.

Q6. The mounting angles for wing and tail.

Q7. The pitch stability derivative.