Aircraft Performance, Stability and control with experiments in Flight

Questions

Q1. If only the elevator size of a given aircraft is decreased; keeping horizontal tail area unchanged; then the aircraft will have

a) increased both static stability and elevator control power
b) increased static stability and reduced elevator control power
c) no change in static stability but decreased elevator control power
d) None of the above.

Q2. When aircraft speed decreases from transonic to subsonic speed, the aerodynamic centre of the wing moves forward, and therefore the **Neutral point (stick fixed**) of the aircraft shifts

a) AFT
b) FWD
c) No effect.

Q3. When an aircraft trim speed is changed from 60 m/s to 100 m/s maintaining the same altitude, **the elevator will float**

a) More
b) less
c) No effect.

Q4. If only the horizontal tail contribution was considered for $C_{m_{\delta_e}}$ derivative, than how many times will $C_{m_{\delta_e}}$ become if tail arm (l_t) is doubled.

a) two times
b) three times
c) four times
d) remains same.

Q5. Load factor for an aircraft in steady descend (gliding mode) is

a) >1
b) <1
c) =1
d) =1.414

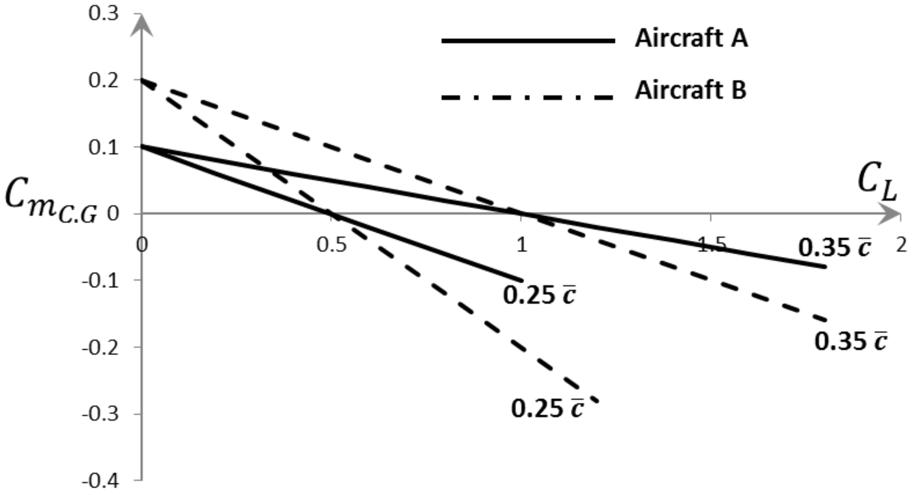
Q6. High wing configurations (increase/ decrease)static longitudinal stabilityof an aircraft

Q7. Most forward C.G. location is more restrictive in (Power on/ Propeller wind milling) condition

Q8. To reduce the floating tendency of an elevator, hinge line has to be moved (AFT/FWD)

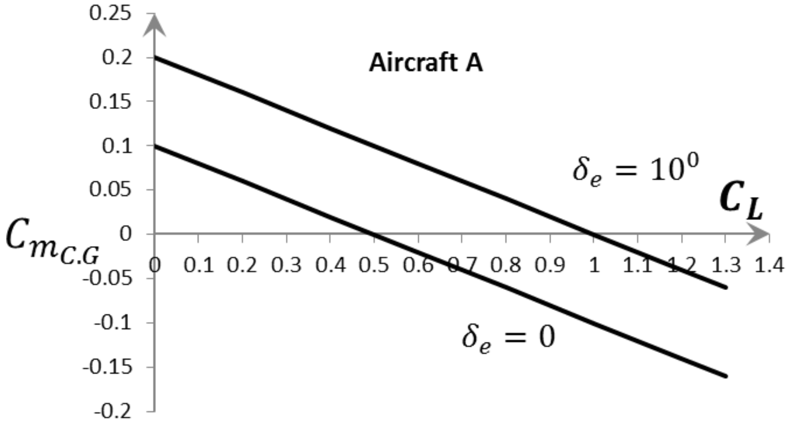
Q9. In figure below, which aircraft will have higher stability margin

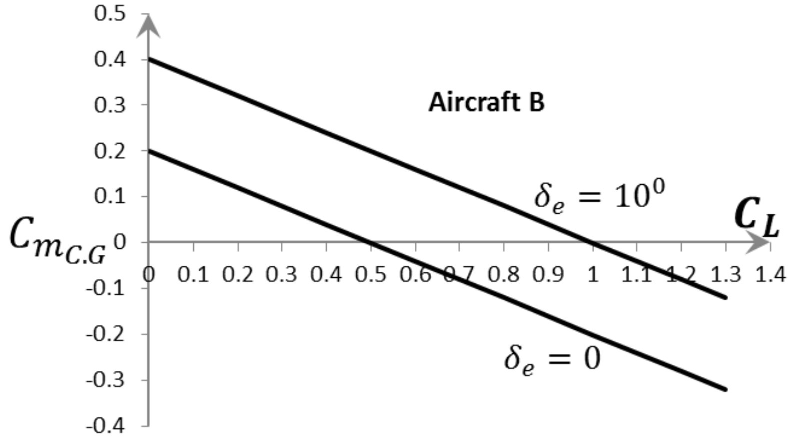
a) A
b) B
c) Equal for A and B



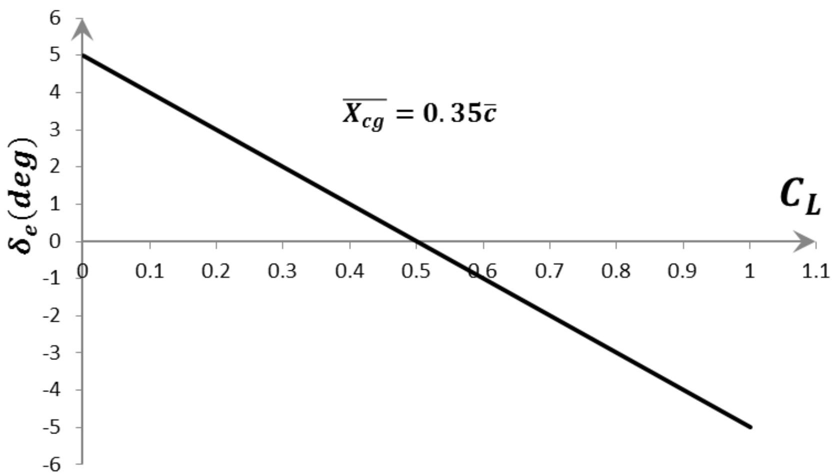
Q10. Which airplane has more control power

a) A
b) B
c) Equal for A and B





Q11. For an aircraft, following data was obtained in flight for propeller-wind milling case. Given that prop-wind milling stick fixed neutral point $, N_o = 0.45$ and $\delta_{e_{max}} = \pm 20°$



a) During the landing phase, C.G. was estimated to be at $0.22\bar{C}$, **calculate the maximum lift coefficient at which the equilibrium can be maintained during landing** (assume No ground effect).

b) If the ground effects were also included, will it permit equilibrium at higher or lower lift coefficient compared to (a) above. Explain briefly

Q12. For an aircraft in pull up maneuver, the following expression was obtained by a student for C.G. location of $0.3\bar{C}$

$$\left(\frac{dF_s}{dn}\right)_{pull\ up} = 120\left(\frac{dC_m}{dC_L}\right)_{free} - 12.0$$

For the aircraft, **stick fixed stability margin was 0.25 and stick free stability margin was 0.2.**

c) Find stick free maneuvering point $N_m^{'}$

d) Find C.G. limits permitted if the magnitude of stick force per 'g'($\frac{dF_s}{dn}$) is to remain within 10 and 30 N per g.

Q13. Consider the following airplane in propeller-off condition being tested in a wind-tunnel.

weight = $700\ kg$ AR_w =6, span wing = 6 m;
wing MAC= $1.2\ m$, AR_{tail} =4, span tail = $2\ m$
$\alpha_0 = -2°\ (wing)$
$i_w = 0$ $i_t = +2°$

2-d lift curve slope of wing and tail = 0.1 per degree
Distance between tail A.C.(aerodynamic center) and C.G. of the aircraft is 6.5 m
Elevator Area = $0.5m^2$
Elevator chord = $0.25m$
$\delta_{e_0} = 3°$

$\tau = 0.4$

$$\frac{\partial\epsilon}{\partial\alpha} = 0.5$$

$\eta_t = 0.9$

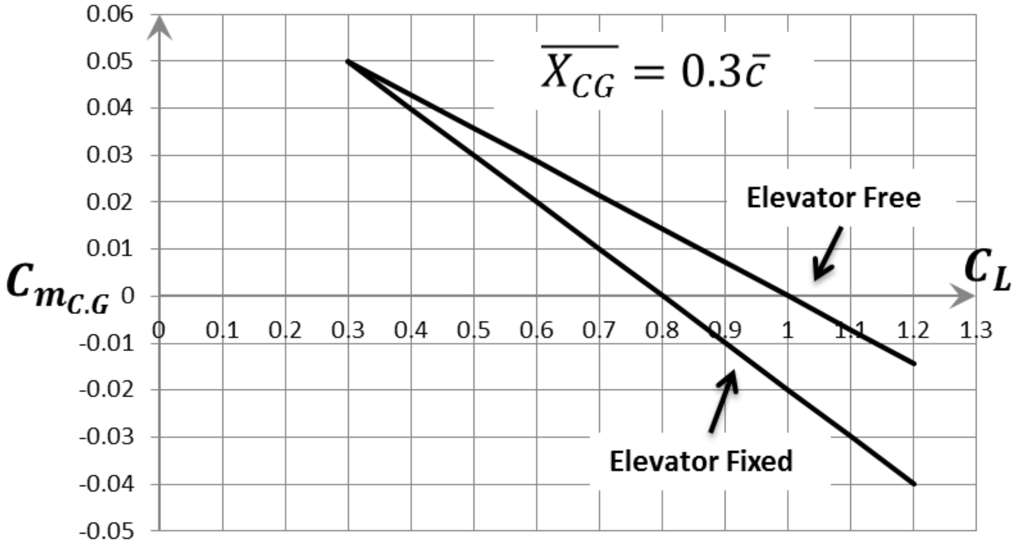
G=1.5 rad/m

$C_{h_{\delta_e}} = -.007$ per degree

$C_{h_\alpha} = -.005$ per degree

$C_{h_{\delta_t}} = -.003$ per degree

The following C_m v/s C_L curve were obtained for elevator fixed and elevator free case



Find:

(a) Stick fixed and stick free Neutral point.

(b) What is the trim airspeed for stick fixed case?

(c) If the aircraft was to be trimmed at airspeed of 200 KMPH, **find the tab setting required and also calculate the magnitude of $\frac{dF_s}{dV}$ for the C.G. location of $0.2\bar{c}$. Assume $C_{m_{\delta_e}}$ does not change.**

Q14. For an airplane (W/S = 400 N/m^2) flying at some altitude (ρ = 0.8 Kg/m^3), the following data were recorded.

V(m/sec)	$\overline{X}_{c.g.} = 0.20$	$\overline{X}_{c.g.} = 0.25$
50	2.0 pull	1.0 pull
57.3	0.0	0.0
70.71	4.0 push	2.0 push

Pull +ve

Find the stick free neutral point.

Q15. For an aircraft having $\overline{\mathrm{X}}_{\mathrm{c.g.}} = 0.3$, the stick force per ‘g’ for level turn at φ = 60^0 was 50 N per ‘g’ $\left(\frac{\mathrm{dF_s}}{\mathrm{d_n}} = 50\right)$. If the stick force per ‘g’ required by the pilot needs to be within 15 to 35 N per ‘g’, find the permissible C.G. range. Given : $\mathrm{N_0^{'}} = 0.4, \mathrm{N_m^{'}} = 0.5$. Solve the problem graphically.

Q16. An airplane was flight tested at an altitude (ρ = 0.8 Kg/m^3) and following information on stick force Fs in newton (N) were available:

Wing loading = 400 Kg/m^2 , wing lift curve slope = $0.1deg^{-1}$

	Speed(m/s)	Alpha(deg)	Fs(N) at $\overline{\mathrm{X}}_{\mathrm{c.g.}} = 0.3$	Fs(N) at $\overline{\mathrm{X}}_{\mathrm{c.g.}} = 0.35$
1.	120	8	3.8 pull	2.8 pull
2.	120	12	8.0 pull	6.0 pull

Find the stick free maneuver point. Solve the problem graphically.

Q17. Derive from the Abinitio for steady cruise flight conditions the following,

(a) V at $\left(\frac{C_L^{\frac{3}{2}}}{C_D}\right)_{max} = 0.76 * V_{\left(\frac{L}{D}\right)_{max}}$

(b) V at $\left(\frac{C_L^{\frac{1}{2}}}{C_D}\right)_{max} = 1.32 * V_{\left(\frac{L}{D}\right)_{max}}$

Q18. How V_{max} for a level cruise will change with respect to the following

(a) $\frac{T_{max}}{W}$

(b) $\frac{W}{S}$

(c) C_{D_0} and K

Q19. Show that the sink rate (V_v) for a glider is given by

$$V_v = \sqrt{2 * \frac{\left(\frac{W}{S}\right)}{\rho\left(\frac{C_L^3}{C_D^2}\right)}}$$

Q20. Show that for sustained level turn $(T = D)$

$$n_{max} = \sqrt{\left(\frac{\frac{1}{2}\rho_\infty V_\infty^2}{K\left(\frac{W}{S}\right)}\left[\left(\frac{T}{W}\right)_{max} - \frac{\frac{1}{2}\rho_\infty V_\infty^2 C_{D_0}}{\frac{W}{S}}\right]\right)}$$