Aircraft Design Questions and Answers – Longitudinal Static Stability and Control-2

1. An aircraft wing is experiencing AOA of 5°. If downwash due to wing is 2.6° then, how much angle is being seen by tail of the aircraft?
a) 2.4°
b) 4.5°
c) 6.7°
d) 1.23°
Explanation: Tail AOA = wing AOA – downwash angle = 5°-2.6° = 2.4°.

3. If an aircraft has lift curve slope of 4.76 per rad and moment coefficient curve slope of -0.116 per rad then, find the location of neutral point. Consider Xcg=0.3.
a) 0.324
b) 0.9825
c) 23.45
d) 45.7
Explanation: Location of neutral point = Xcg – moment coefficient slope/lift curve slope
= 0.3 – 0.116/4.76 = 0.3-0.024 = 0.324.

4. Canard will provide longitudinal static stability.
a) False
b) True
Explanation: Canards are typically used to provide longitudinal instability. Canards are located at the forward section of the aircraft. They are located ahead of the CG of aircraft typically. Hence, if some disturbance is given then, it will not have initial tendency to return to its original equilibrium position. Hence, it will not provide static stability.

5. Thrust will affect the stability of the aircraft.
a) True
b) False
Explanation: Thrust is a propulsive force produced by the engine of an aircraft. Thrust will affect the stability of the aircraft. The direct moment of the thrust, inlet normal force due to turning of air etc. will influence on the aircraft stability.

6. Determine trim angle if, trim lift coefficient is 0.75 and lift curve slope is 4.5per rad. Consider elevator deflection as 1.056 per rad and trim elevator angle of 0.020 rad.

a) 0.1619 rad b) 0.1619° c) 2.98 rad d) 34.23 rad
Explanation: Trim lift coefficient C = 0.75, lift curve slope c = 4.5 per rad, elevator deflection e = 1.056 per rad, and trim elevator angle E = 0.020 rad.
Trim angle = [C- e*E]/c = [0.75-1.056*0.020]/4.5 = [0.75-0.02112]/4.5

= 0.728/4.5 = 0.1619 rad.

7. Find elevator control power in per rad.

	Cm	**δe (rad)**
1	0.02	1.1
2	0.08	-2.5

a) -0.0166 per rad b) -12.33 per rad c) 0.0015 per rad d) 0.098 per rad
Explanation: Elevator control power Cmδe = (Cm of 1 – Cm of 2) / (δe of 1 – δe of 2)
= (0.02-0.08)/(1.1-(-2.5)) = -0.0166 per rad.

8. Determine required static margin if lift curve slope is 6.5 per rad and pitching moment coefficient slope as -0.58 per rad.
a) 8.9% b) 78% c) 0.89 d) 8.403
Explanation: Static Margin = – (moment coefficient slope/lift curve slope)
= -(-0.58/6.5) = 0.089 = 0.089*100% = 8.9%.

9. If SM = 0.12 and cg is located at 20% chord from leading edge. then, find appropriate neutral point location.
a) 0.32 b) 0.87 c) 2.3 d) 1.54
Explanation: Given, SM = 0.12, Xcg = 0.2 (20% of chord = 0.2*chord)
Neutral point position = SM + Xcg = 0.12 + 0.2 = 0.32.

10. Find the appropriate value of pitching moment coefficient derivative if lift curve slope is 0.032 per degree and Xcg is 0.3. Consider neutral point is located at 60 % of chord from leading edge.
a) -0.0096 per degree
b) -7 per degree
c) 2.56 per degree
d) 0.1
Explanation: Given, lift curve slope C= 0.032 per degree, Xcg = 0.3
Neutral point is located at 60% of chord i.e. Xnp = 0.6.
Pitching moment derivative = -C*[Xnp-Xcg] = -0.0032*[0.6-0.2] = -0.0096 per degree.

11. A rectangular wing has chord of 2m. Fond neutral point for this wing.
a) 50 cm b) 290 cm c) 189 cm d) 267 cm
Explanation: For rectangular wing, Location of neutral point = chord/4 = 2/4 = 0.5m = 50cm.

12. If C_{M0} is -0.052 and lift coefficient at zero angle C_{L0} is 0.92 then, find C_{Mac}. Consider rectangular wing.

a) -0.282 b) 0.98 c) 2.5 d) 7.89

Explanation: CMac = CM0 +CL0*[Xcg-Xac]

For a typical rectangle wing, Xcg-Xac =0.25.

Hence, CMac = CM0 + CL0*0.25 = -0.052+0.95*0.25 = -0.282.

13. Elevator control power is given by _____

a) $dC_{m\,/}\,d\delta e$

b) Zero lift drag

c) T = CD0 + K*CL

d) DCL/α

Explanation: Elevator control power is defined as the change in moment coefficient to the change in elevator angle. Elevator control power is given by, $C_{m\delta e}$ = dCm/dδe Where, $C_{m\delta e}$ is known as elevator control power. Larger value indicates more effectiveness of control power.

14. Determine the corrections or otherwise of the following Assertion [A] and Reason [R]:

Assertion [A]: For longitudinal static stability of an aircraft, slope of moment curve should be negative.

Reason[R]: Positive slope will result in more static stability than negative slope. Hence, slope should be positive always.

a) Both [A] and [R] are true and [R] is the correct reason for [A]

b) Both [A] and [R] are true but [R] is not the correct reason for [A]

c) [A] is true but [R] is false d) [A] is false but [R] is true

Explanation: For longitudinal static stability of the aircraft, slope of moment coefficient curve should be less than zero. Hence, slope should be negative. Negative slope will provide static stability whereas positive slope will result in statically unstable aircraft. Hence, [A] is true but [R] is false.

15. Which of the following is correct to trim an aircraft at positive AOA?

a) $C_{m0} > 0$ b) $C_{m0} < 0$ c) C_{m0} will not affect positive trim AOA

d) Every value of cm0 will trim at positive AOA

Explanation: To trim an aircraft at positive AOA, it is required that aircraft has positive value of zero lift moment coefficient. Hence, to trim aircraft at a positive angle of attack, aircraft should be designed with C_{m0} positive i.e., C_{m0}>0. Negative value of Cm0 will not allow the aircraft to trim at positive AOA.