MT BOQ Advance

Examples:

1. If Lift produced by wing is 350N then, determine lift coefficient. Given q = 35Pa and S=8.5 m^2.

   Solution: Lift coefficient = lift / q*S = 350/35*8.5 = 1.174.

2. For a symmetrical airfoil drag coefficient at zero lift is 0.05 and induced drag coefficient is 0.0025. Find the total drag coefficient.
   Solution:
   Total drag coefficient = drag coefficient at zero lift + induced drag coefficient

   = 0.05+0.0025 = 0.0525.

3. Determine sideslip angle for a steady level unaccelerated flight with
   [u, v, w] = [80, 2, 4.5].
   Solution: Given, v = 2, V = $[u^2+v^2+w^2]^{0.5}$ = $[80*80+2*2+4.5*4.5]^{0.5}$ = 80.1521.
   Sideslip angle = arcsine (v/V) = arcsine (2/80.1521) = 1.43°.

4. Determine the value of climb angle if, excess thrust is 40 unit and weight of the aircraft is 60 unit. Consider steady climb.

   Solution: Given, Excess thrust = T-D, steady flight (T-D) = 40

   (T- D) – W sin(climb angle) = 0

   Hence, Climb angle = arcsine (excess Thrust/weight) = arcsine (40/60) = 41.8°.

5. A wing is designed to operate with free stream velocity of 20m/s and air density of 1.225 kg/m^3. Find aerodynamic efficiency of given wing. Consider S as 8 m^2, CL as 0.9 and CD as 1.25.
   a) 0.72 b) 2 c) 3 d) 5.23
   Solution : Given, CL = 0.9, CD = 1.25
   Aerodynamic efficiency is defined as the ratio of CL and CD of the aircraft.
   Hence, Aerodynamic efficiency = CL/CD = 0.9/1.25 = 0.72.
6. An aircraft experiences sideslip of 4° and side wash at vertical tail is 1.2°. What will be the AOA at vertical tail?
   Solution: AOA = sideslip + side wash = 4°+1.2° = 5.2°.
7.

Problems

8. With the aid of a diagram showing a generalized set of aircraft body axes, define the parameter notation used in the mathematical modeling of aircraft motion1.

9. In the context of aircraft motion, what are the Euler angles? If the standard right handed aircraft axis set is rotated through pitch θ and yaw ψ angles only, show that the initial vector quantity (x0, y0, z0) is related to the transformed vector quantity (x, y, z) as follows:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \cos\theta\cos\psi & \cos\theta\sin\psi & -\sin\theta \\ -\sin\psi & \cos\psi & 0 \\ \sin\theta\cos\psi & \sin\theta\sin\psi & \cos\theta \end{bmatrix} \begin{bmatrix} x_0 \\ y_0 \\ z_0 \end{bmatrix}$$

10. Define the span, gross area, aspect ratio and mean aerodynamic chord of an aircraft wing.

11. 4. If an aircraft is operating with dynamic pressure of the free stream q=20Pa and has area of wing is $10m^2$ then evaluate drag experience by the aircraft. Given drag coefficient
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13. An aircraft is flying in the north direction at a velocity of 60.5m/s under cross wind from the east to west of 5m/s. If the value of Cnβ=0.02/deg, where. Find sideslip angle β.
14. Find sideslip angle if [u, v, w] = [100, 5, 2.5]. Consider steady level flight.
15. Find lift to weight ratio if climb angle is 45°.
16. Find the approximate value of climb angle if Thrust is 1500N, drag is 1000N and weight of the aircraft is 2500N
17. Given ($F = d\, mV_T/dt$) , F is a force vector, m is a constant mass, and V_T is the velocity vector of the mass center. Find Fx , Fy , and Fz (if V_T = Ui + Vj + Wk and w = Pi + Qj + Rk) with respect to the fixed earth axis system.
18. Given H = $\int_v \rho A$ (r X v) dv where pAdV is the mass of a particle, with r as its radius vector from the eg, and V as its velocity, with respect to the eg. Find Hx with respect to the fixed earth axis system.
19. Define: L , M , N, P, Q, R
20. Define ψ, ϕ, θ, What are they used for? in what sequence must they be used? Explain the difference between ψ and ß.
21. What are the expressions for P, Q, R, in terms of Euler angles?
22. D, L, M = f(, , , ,)

Y, L, N = f(, , , , ,)

MCQ

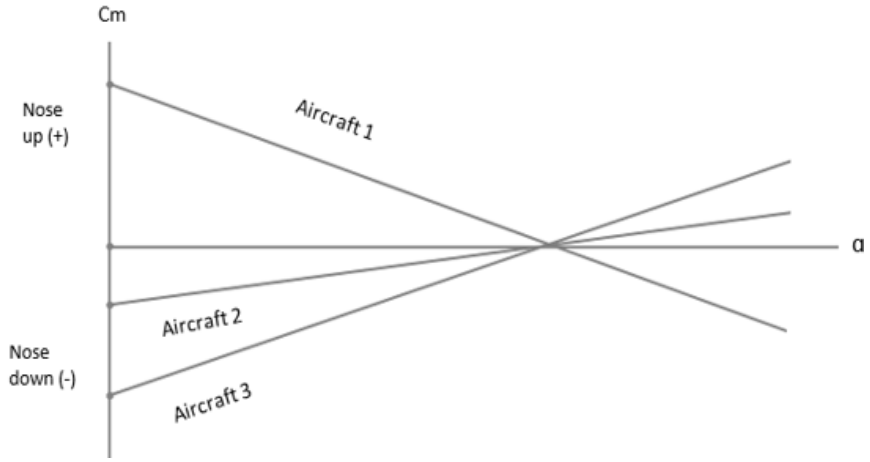
Choose correct answer, Describe your selection :

1. Which of the following is correct?
    a. a) Lift is equal to weight always b) Thrust is only proportional to nose of aircraft c) Aircraft which is statically stable may or may not be dynamically stable d) Drag is useful during takeoff
2. How do you define the lift coefficient?
    a) Ratio of aerodynamic lift to the dynamic lift b) Lift to drag
    c) Wing lift to weight of aircraft d) Thrust to weight
3. Which of the following is correct?
    a) $D = q*S*C_D*\rho$ b) $D = q*C_D$ c) $D = q$ d) $D = q*S*C_D$
4. For an incompressible flow, if local area velocity decreases then, the dynamic pressure will _____
    a) decrease b) increase c) constant d) independent of velocity
5. For ideal flow, total pressure along streamline will be _____.
    a) increases b) decreases c) constant d) always decreases by half
6. Aerodynamic forces are generated due to _____
    a. a) shear effects only b) only pressure forces
    b. c) shear and pressure force acting on body. d) twisting of beam
7. The change in local air flow velocity will produce small change in skin friction drag.
    a. a) True b) False
8. How do you define the lift coefficient?
    a. a) Lift to drag b) Ratio of aerodynamic lift to the dynamic lift
    c) Wing lift to weight of aircraft d) Thrust to weight
9. Which of the following is correct?
    a. a) $D = q$ b) $D = q*S*CD*\rho$ c) $D = q*CD$ d) $D = q*S*CD$
10. Aircraft is said to be statically stable if _____
    a. it has more thrust than drag
    b. it has tendency to return to equilibrium state with the help of pilot's input
    c. it has more lift than weight always
11. How can we say that the aircraft has initial tendency to return to its original equilibrium position after being disturbed?
    a. If restoring force is not generated to oppose the disturbance
    b. If lift is same as weight always.
    c. If aircraft generates some restoring force or/and moment without any external help.
    d. If thrust loading is always unity.
12. Longitudinal stability means _____
    a. stability about yawing axis

b. stability about pitching axis
c. stability about lateral axis
d. stability about negative yawing axis

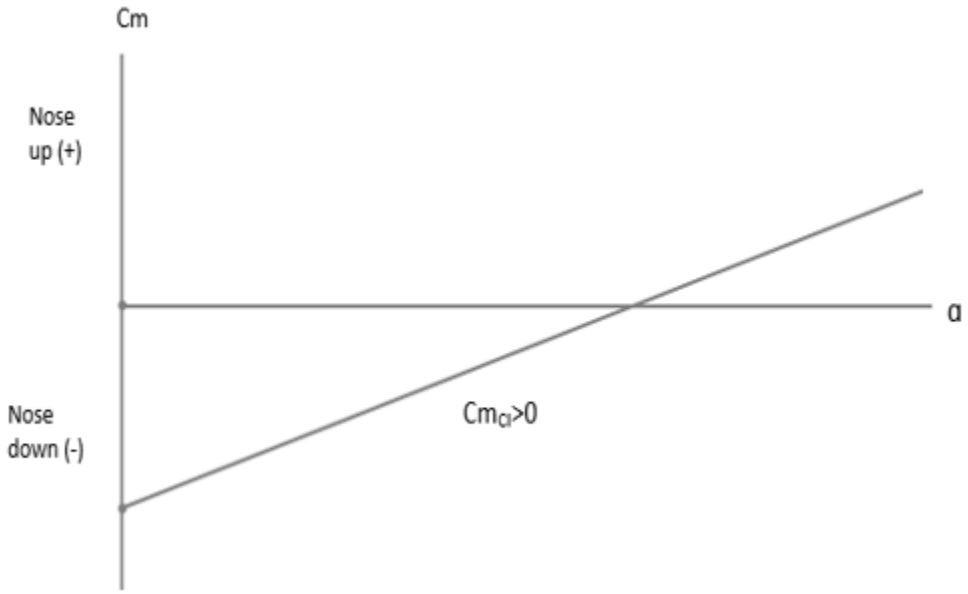
13. Which is the minimum requirement for pure directional stability?
    a) Positive zero lift pitching moment coefficient b) Negative lift curve slope
    c) Slope of yawing moment curve positive
    d) Negative pitching moment coefficient curve slope
14. Which of the following is correct to trim an aircraft at positive AOA?
    a) Every value of cm0 will trim at positive AOA b) Cm0 < 0
    c) Cm0 will not affect positive trim AOA d) Cm0 > 0
15. Drag which is **produced due to lift is called?**
    a) Induced drag b) Parasite drag c) Weight d) Thrust drag
16. The change in local air flow velocity will produce small change in skin friction drag.
    a) True b) False
17. Dynamic stability is more concerned about time.
    a) True b) False
18. Stability about yawing axis is called as _____
    b) lateral stability c) longitudinal stability c) directional stability
    d) pitching moment stability
19. Yawing moment is positive if _____
    a) right wing comes forward b) right wing goes back c) if nose pitches up
    d) if nose pitches down
20. Stability about roll axis is called _____
    a) lateral stability b) directional stability c) longitudinal stability d) elevator control
21. Rolling moment will influence _____
    a) longitudinal stability b) pitch axis stability c) pitching stability only
    d) aircraft lateral stability
22. . If aircraft continues to go farther away from equilibrium position after being disturbed then the aircraft is called _____
    a) stable b) unstable c) statically stable d) neutrally stable

23. Which of the aircraft will be statically stable based on following diagram?



a) aircraft number 2 b) aircraft number 3 c) aircraft number 1
d) same static stability for all 3 aircrafts

24. Following diagram represents _____



a) pitching moment diagram for stable aircraft b) lift curve slope
c) drag polar d) pitching moment coefficient diagram of unstable aircraft

25. Which of the following is correct?
a) Aircraft static longitudinal stability will be dependent upon the arrangement of different components
b) Lift is always same as weight
c) Static stability is similar to dynamic stability
d) All the aircrafts are statistically stable
Explanation: Static longitudinal stability of aircraft will be dependent upon the arrangement of different components such as wing placements, tail location etc. At cruise condition or at trim position lift will be same as weight. Static stability and dynamic stability are different. System can be statically stable but that doesn't mean that the system is dynamically stable as well.

26. Ratio of vertical distance travelled to the horizontal distance travelled is known as _____

    a) lift curve slope b) power required c) climb gradient d) thrust loss

27. Consider the vertical velocity of the aircraft is 10m/s and horizontal velocity is 12 m/s. Determine the value of climb gradient.

    a) 1.89 b) 8 c) 2.483 d) 0.833

28.

29.

30.