Lateral-Directional Static Stability and Control

1. Stability about yawing axis is called as __________
a) directional stability b) lateral stability c) longitudinal stability
d) pitching moment stability
Explanation: Directional stability of the aircraft is defined as the stability about the yawing axis. In typical aircraft yaw and rolling both will be produced by deflecting the rudder. Stability about rolling moment is called lateral stability.

2. Yawing moment is positive if __________
a) right wing goes back b) right wing comes forward c) if nose pitches up
d) if nose pitches down
Explanation: Yawing moment is said to be positive by sign convention if right wing goes back and vice versa. If nose pitches up then it is a positive pitching moment and similarly if nose pitches down it is called negative pitching moment as per the sign convention is considered.

3. Stability about roll axis is called _____________
a) lateral stability b) directional stability c) longitudinal stability d) elevator control
Explanation: Stability about the rolling is termed as lateral stability. Lateral and directional stability are closely coupled. When we deflect only aileron it will generate rolling as well as it will also cause the aircraft to yaw. Longitudinal stability is Stability about pitching moment. Elevator is used for such purposes.

4. If aircraft is in straight flight (cruise with lift of 100N) then, what will be the value of net rolling moment? Consider ideal conditions.
a) 0 unit b) 12 Nm c) 23 unit d) 25 N/m
Explanation: Given, aircraft is in cruise, lift = 100N.
At cruise condition, net rolling moment is zero. As at cruise all the forces and moments are in equilibrium or in balanced.

5. Which is the minimum requirement for pure directional stability?
a) Slope of yawing moment curve positive b) Negative lift curve slope
c) Negative pitching moment coefficient curve slope
d) Positive zero lift pitching moment coefficient
Explanation: An aircraft is said to be in directional stability if the yawing moment curve slope is positive. Negative pitching moment coefficient curve slope is minimum criteria for longitudinal static stability. Positive value of zero lift pitching moment coefficient will be used to design an aircraft to trim at positive AOA.

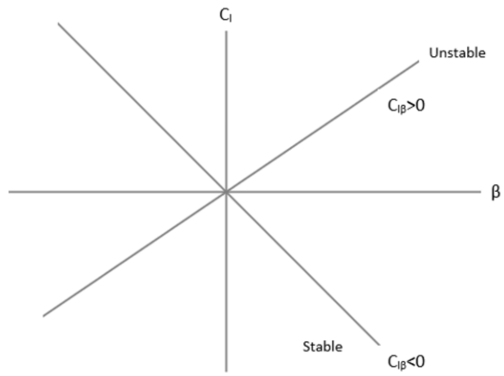
6. Rolling moment will influence _______
a) aircraft lateral stability b) longitudinal stability
c) pitch axis stability d) pitching stability only
Explanation: Rolling moment will influence the aircraft lateral stability. It also affects the

yawing and therefore directional stability of the aircraft. Longitudinal stability is used for pitching moment.

7. Following diagram represents ____________

a) typical roll stability concept b) typical longitudinal stability

c) lift curve d) drag polar



Explanation: Above diagram is illustrating the concept of roll stability. Typical lateral stability criteria can be observed in the diagram. Longitudinal stability is represented by using pitching moment curve. Lift curve will be used to provide relationship between lift and angle of attack. Drag polar will correlate drag and lift.

8. An aircraft experiences sideslip of 4° and side wash at vertical tail is 1.2°. What will be the AOA at vertical tail?

a) 5.2° b) 6.89° c) 1.2° d) 21.3°

Explanation: AOA = sideslip + side wash = 4°+1.2° = 5.2°.

9. Aircraft can suffer from adverse yaw during rolling.

a) True Answer: a

Explanation: Yes, it is true that aircraft can suffer from the adverse yaw phenomenon due to rolling motion. When an aircraft is banked to execute turning operation, the aileron may produce a yawing motion that opposes the turn. This is called adverse yaw.

10. 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.

a) -4.72° b) -5° c) 4.7° d) 3.18°

Explanation: Given, North velocity n = 60.5m/s, East to west velocity e = 5m/s.

For given cross wind condition sideslip angle β is given by,

β = -arctan (e/n) = -arctan (5/60.5) = -4.72°.

11. Determine the value of rudder deflection δr for an aircraft which is flying in north with the velocity of 60.5 m/s under the crosswind of 5m/s from east to west with $Cn\beta$=0.02/deg and $Cn\delta r$ = -0.045/deg, where sideslip angle β is -4.72°.
a) -2.09° b) 3.5° c) -4.5° d) -4.74°
Explanation: Given, North velocity n = 60.5m/s, East to west velocity e = 5m/s.
Now, rudder deflection $\delta r = -[Cn\beta/ Cn\delta r]*\beta = -[0.02/-0.045]*(-4.72) = -2.09°$.

12. Find sideslip angle if [u, v, w] = [100, 5, 2.5]. Consider steady level flight.
a) 2.86° b) 4.5° c) 4.7° d) 2.1°

Explanation: Given, v = 5, $V = [u^2+v^2+w^2]^{0.5} = [100*100+5*5+2.5*2.5]^{0.5} = 100.156$.
Sideslip angle = arcsine (v/V) = arcsine (5/100.156) = 2.86°.

13. Find resultant velocity if [u, v, w] = [80, 2, 4.5]. Consider steady level flight.
a) 80.151 b) 90 c) 10.52 d) 100.159
Explanation: Resultant Velocity $V = [u^2+v^2+w^2]^{0.5} = 80.1521$.

14. Determine sideslip angle for a steady level unaccelerated flight with [u, v, w] = [80, 2, 4.5].
a) 1.43 b) 5.4 c) 5 d) 12.32
Explanation: 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°.

15. Determine the net velocity if sideslip angle is 3.8 degree and [v] = 4.2 unit.
a) 63.23 unit b) 100 unit c) 100.23 unit d) 102.623 unit
Explanation: Net velocity V = v/sine (sideslip) = 4.2*sine (3.8°) = 63.23 unit.