Dynamic Stability

This set of Aircraft Design Multiple Choice Questions & Answers (MCQs) focuses on “Dynamic Stability”.

1. Which of the following is correct?
a) Aircraft which is statically stable may or may not be dynamically stable
b) Lift is equal to weight always
c) Thrust is only proportional to nose of aircraft
d) Drag is useful during takeoff
Explanation: If an aircraft has initial tendency to return to its original equilibrium condition after being disturbed then, it is said that the aircraft is statically stable. However, it does not mean that the aircraft is dynamically stable as well. Dynamic stability is defined by certain finite time period. Lift is not always same as weight.

2. Dynamic stability is more concerned about time.
a) True b) False

Explanation: Yes, it is true. Dynamic stability is more concerned about time. If an aircraft has initial tendency to return to its equilibrium position after displaced then, it is called that the aircraft has static stability. Dynamic stability accounts for the time required for returning to original equilibrium position. System can be dynamically stable but may or may not be statically stable.

3. Damping ratio is defined as _____
a) damping coefficient divided by critical damping coefficient
b) lift to drag
c) thrust to weight
d) weight to power
Explanation: Damping ratio is defined as ratio of damping coefficient to the critical damping coefficient. Lift to drag ratio is used to provide information about aerodynamics of the aircraft. It is often termed as aerodynamic efficiency. Thrust to weight ratio is called Thrust loading.

4. Which of the following is correct?
a) Wn = $\sqrt{\frac{k}{m}}$
b) Wn = 1.2* $\sqrt{\frac{k}{m}}$
c) Wn = 2*k
d) Wn = $\sqrt{\frac{1}{m}}$

Explanation: A typical relation of natural frequency is illustrated in the above question. Natural frequency in the terms of spring coefficient and mass can be given as follows Wn = km−−√ where, Wn = natural frequency, k is spring coefficient and m is mass of the system.

5. An aircraft is consider to be over damped. What will be the appropriate value for damping ratio?
a) 1.45
b) 0.1
c) 0.001
d) 0.04
Explanation: For overdamped system, value of damping ratio is greater than 1.
Hence, among the given options, 1.45 is correct answer as it is > 1.

6. If damping ratio is unity then, system is _____
a) critically damped b) over damped c) high lift device d) thrust augmented
Explanation: Damping ratio is defined as damping coefficient divided by critical damping coefficient. If damping ratio is unity then, the damping coefficient is equal to the critical damping coefficient. Hence, for such scenario system is said to be critically damped.

7. Consider the aircraft with weight of 1234 kg. Find the approximate value of the damping ratio if time taken by system for damping is minimum.
a) 1 b) 1.7 c) 1.9 d) 0.002

Explanation: For minimum damping time, system should be critically damped.
For, critical damping ratio is defined as,
Damping ratio = damping coefficient/critical damping coefficient = Cc/Cc = 1.

8. Find critical damping coefficient if damping ratio is 0.5 and damping coefficient is 1.1.
a) 2.2 b) 1 c) 4 d) 1.1
Explanation: Critical damping coefficient damping coefficient/ damping ratio 1.1/0.5 = 2.2.

9. Which of the following is not the type of aircraft dynamic mode?
a) Flap b) Dutch roll c) Phugoid d) Lateral mode

Explanation: Flap is a high lift device. Flap is used to increase lift produced by the wing. Flaps are used to increase camber and overall surface area of the wing. This results in increased lift. Dutch roll, phugoid, lateral mode etc. are typical aircraft dynamic modes.

10. Which of the following is an example of longitudinal mode?
a) Phugoid b) Dutch c) Lateral d) Aileron
Explanation: Phugoid mode is an example of longitudinal mode. Dutch and lateral mode are not example of longitudinal mode. Aileron is known as primary control surface. Aileron is used to control the aircraft rolling moment.

11. Consider the 2d phugoid approximation with natural frequency of 0.4. Determine the approximate value of aircraft speed.
a) 34.68 b) 56 c) 12 d) 12.68
Explanation: Given, natural frequency w = 0.4
Approximate value of aircraft speed = 1.414*g/w = 1.414*9.81/0.4 = 34.68 m/s.

12. If damping ratio is 0.05 then, find the lift to drag ratio. Consider 2-degree phugoid approximation.
a) 14.14 b) 20 c) 25 d) 0.05
Explanation: Given damping ratio d = 0.05
Lift to drag = 0.707/d = 0.707/0.05 = 14.14.

13. Which of the following is correct?
a) Dutch roll is not considered as a longitudinal mode
b) Lift curve slope is defined as ratio of lift to thrust
c) Stability and controllability are same
d) Dynamic stability of aircraft does not depend upon any parameter

Explanation: Dutch roll is not longitudinal mode. Typical longitudinal modes include phugoid mode and short period mode. Lift curve slope is defined as ratio of change in lift coefficient to the change in AOA. Stability and controllability are inverse of each other.