CBCS SCHEME

USN | | | | | | | | | | |

15AE73

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
Aircraft Stability and Control

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Derive an expression for tail contribution $\left(\frac{C_M}{C_L}\right)_{tail}$ for the static longitudinal stability of an airplane and discuss the downwash at the tail. **(10 Marks)**

b. Define stick fixed neutral point. Write down the expression for stick fixed neutral point and discuss the effect of C.G. shift on pitching moment. **(06 Marks)**

OR

2 a. Given the general aviation aviation with the following configuration details : Gross weight = 2750 kg , Velocity = 176 m/s , $X_{cg} = 0.295\,\overline{C}$, Span = 33.4M , $\overline{C}$ = 5.7M, Tail area = $43m^2$, Tail arm = 16M , $\eta = 0.8$, $\frac{se}{st} = 0.3$, $C_{L\alpha t}$ = 3.9/ rad. Assume pitching moment curves for the landing configuration at the forward most C.G. position is given as $C_{m_{cg}} = -0.20 - 0.035\alpha$, where α in degrees. Estimate the elevator effectiveness and size of the elevator to trim the airplane at the landing angle of attack of 10°. Assume elevator angle is constrained to +20 ° and -25 ° . **(10 Marks)**

b. Derive the expression for elevator control power : $C_{m_{\delta e}} = -V_H \eta C_{L_{\alpha t}} \tau$. **(06 Marks)**

Module-2

3 a. Explain Hinge Moment Parameters. **(08 Marks)**

b. Derive the equation for stick free Neutral points. **(08 Marks)**

OR

4 a. Briefly explain the requirements for directional control and obtain the expression for rudder control effectiveness , $C_{n_{\delta_r}}$. **(10 Marks)**

b. What is meant by 'Rudder lock', 'Dorsal fin' and 'Weather cocking effect'? **(06 Marks)**

Module-3

5 a. Define dihedral angle and dihedral effect with neat sketch. **(06 Marks)**

b. Explain methods of Aileron Balancing with neat sketch. **(10 Marks)**

OR

6 a. Define longitudinal dynamic stability of aircraft and plot types of modes of motion and discuss on phugoid and short period motion. **(10 Marks)**

b. Obtain relation for roll control power $\left(C_{L_{\delta_a}}\right)$. **(06 Marks)**

Module-4

7 a. Derive Rigid body equation of Motion. (12 Marks)

b. Briefly explain Gravitational and thrust forces acting on the airplane. (04 Marks)

OR

8 a. Starting with X-force equation, use the small disturbance theory to determine the linearized force equation. Assume a steady level flight for the reference flight conditions. (10 Marks)

b. Obtain derivatives due to the pitching velocity. (06 Marks)

Module-5

9 a. Explain Routh's criterion and determine whether the characteristic equations given below have stable or unstable roots :

$\lambda^3 + 6\lambda^2 + 12\lambda + 8 = 0$; $2\lambda^3 + 4\lambda^2 + 4\lambda + 12 = 0$. (08 Marks)

b. Explain Dutch roll and Spiral instability with relevant sketches (08 Marks)

OR

10 Write short notes on the following :

a. Flying qualities.

b. Cooper – Harper scale.

c. Wind shear.

d. Auto-rotation and spin. (16 Marks)

* * * * *