

# CBCS SCHEME

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15AE73

## Seventh Semester B.E. Degree Examination, Jan./Feb. 2021 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. Explain longitudinal static stability. (06 Marks)
- b. Derive an expression for wing contribution  $\left(\frac{dc_m}{dc_L}\right)_w$  for the longitudinal static stability of an airplane and discuss the significance of C.G. position with respect to the wing aerodynamic center. (10 Marks)

OR

- 2 a. Define stick fixed neutral point and static margin. Give the expression for stick fixed neutral point and discuss the effect of C.G. shift on pitching movement. (08 Marks)
- b. A high performance glider has the following characteristics:  $C_D = 0.02 + 0.025C_L^2$ ,  $C_{L\alpha_w} = 0.093$ ,  $\alpha_{OL_w} = -4$ ,  $i_w = 0$ ,  $C_{m\alpha_c} = -0.08$ ,  $X_{ac} = 0.24 \bar{C}$ ,  $S_t = \frac{S}{7}$ ,  $l_t = 4 \bar{C}$ ,  $\epsilon = 0.4 \alpha$ ,  $C_{L\alpha_t} = 0.05$  and  $\eta = 0.9$ . All the angles are in degrees. Neglect the contribution of fuselage. Find the C.G. location ( $X_{cg}$ ) for which the equilibrium is reached with zero lift on the tail at the lift coefficient corresponding to the best gliding angle. Calculate the tail settling angle ( $i_t$ ). Is the glider stable? (08 Marks)

### Module-2

- 3 a. Briefly explain hinge moment parameters and trim tabs. (08 Marks)
- b. Obtain the expression for  $(\delta_e)_{free}$ : elevator deflection condition for stick-free condition. (08 Marks)

OR

- 4 a. Explain the following terms using in directional control:  
(i) Adverse yaw (ii) Cross Wind Landings  
(iii) Asymmetric power (iv) Spin recovery (08 Marks)
- b. Explain the function of dorsal fin in directional stability. Also explain with example of the effect of dorsal fin on pedal free versus sideslip characteristics. (08 Marks)

### Module-3

- 5 a. Explain dihedral effect and describe on the aspect of estimation of airplane dihedral effect. (08 Marks)
- b. Obtain the relation for lateral control power  $(C_{l\delta_a})$ . (08 Marks)

OR

- 6 a. Explain the various methods of Aileron Balancing. (06 Marks)
- b. Briefly describe the longitudinal types of modes with relevant sketches of phugoid motion and short period motion. (10 Marks)

Module-4

- 7 a. Derive rigid body equation of motion. (12 Marks)  
 b. Briefly explain gravitational and thrust forces. (04 Marks)

OR

- 8 a. Explain with expressions of aerodynamic forces and moments representation. (10 Marks)  
 b. Derive the derivatives due to the time rate of change of angle of attack. (06 Marks)

Module-5

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

i)  $\lambda^4 + 2\lambda^3 + 5\lambda^2 + 2\lambda + 2 = 0$

ii)  $\lambda^3 + 6\lambda^2 + 12\lambda + 8 = 0$

(08 Marks)

- b. Write short note on Cooper-Harper scale. (08 Marks)

OR

- 10 Write short notes on the following:

- a. Wing rock  
 b. Roll control reversal  
 c. Dutch roll instability  
 d. Autorotation and spin

(16 Marks)

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