CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐ **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: $C_D = 0.02 + 0.025C_L^2$, $C_{L_{\alpha w}} = 0.093$, $\alpha_{OL_w} = -4$, $i_w = 0$, $C_{m_{ac}} = -0.08$, $X_{ac} = 0.24\,\bar{C}$, $S_t = \frac{S}{7}$, $\ell_t = 4\bar{C}$, $\varepsilon = 0.4\,\alpha$, $C_{L_{\alpha t}} = 0.05$ 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 $\left(C_{\ell_{\delta_a}}\right)$. **(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)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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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