

# CBCS SCHEME

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15AE73

## Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019 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 aircraft with the following configuration details: Gross weight = 2750 kg, velocity = 176 m/s,  $X_{cg} = 0.295\bar{C}$ , span = 33.4M,  $\bar{C} = 5.7M$ , Tail area = 43m<sup>2</sup>, Tail arm = 16M,  $\eta = 0.8$ ,  $\frac{se}{st} = 0.3$ ,  $C_{Lat} = 3.9/\text{rad}$ . 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  $\alpha$  in degrees. Estimate the elevator effectiveness and size of the elevator to trim the aircraft 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:  $C_{m_{\delta e}} = -V_H \eta C_{Lat} \tau$ . (06 Marks)

### Module-2

- 3 a. Briefly explain Hinge moment parameters and trim tabs. (08 Marks)
- b. Derive an expression for stick-free neutral point with necessary graphs. (08 Marks)

OR

- 4 a. Briefly explain the requirements of directional control and obtain the expression for rudder control effectiveness  $C_{n_{\delta r}}$ . (10 Marks)
- b. What is meant by 'Rudder lock' and 'Dorsal fin'? (06 Marks)

### Module-3

- 5 a. Explain Dihedral effect. (04 Marks)
- b. Explain the effect of wing sweep, flaps and dihedral on dihedral effect with neat diagram. (08 Marks)
- c. What are the advantages and disadvantages of frise aileron? (04 Marks)

OR

- 6 a. Explain the various methods of aileron balancing. (06 Marks)
- b. Define longitudinal dynamic stability and briefly describe the following 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 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 criteria and factors affecting period and damping of oscillations. (08 Marks)  
b. Write short notes on the following: (08 Marks)  
i) Effect of wind shear  
ii) Cooper-Harper scale.

**OR**

- 10 a. Describe the dynamic lateral stability considering rudder free case. (08 Marks)  
b. Explain the following: (08 Marks)  
i) Dutch roll  
ii) Auto rotation-spin stability.

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