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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 $\left(\dfrac{C_M}{C_L}\right)_{tail}$ 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 = 43m², Tail arm = 16M, $\eta = 0.8$, $\dfrac{se}{st} = 0.3$, $C_{L_{\alpha t}} = 3.9/rad$. 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. 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 power 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:
   i)   Effect of wind shear
   ii) Cooper-Harper scale. (08 Marks)

OR

10 a. Describe the dynamic lateral stability considering rudder free case. (08 Marks)

b. Explain the following:
   i)   Dutch roll
   ii) Auto rotation-spin stability. (08 Marks)

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