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18AE71

Seventh Semester B.E. Degree Examination, June/July 2024
Aircraft Stability and Control

Time: 3 hrs.

Max. Marks: 100

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

Module-1

1 a. The wing fuselage pitching moment characteristics of a high-wing, single-engine, general aviation airplane follow, along with pertinent geometric data: $C_{m_{Cg_{wf}}} = -0.05 - 0.0035\alpha$ where α is the fuselage reference line angle of attack in degrees and wf means wing fuselage. $S_w = 178$ m², $\frac{X_{C_g}}{\bar{c}} = 0.1$, $b_w = 35.9$ m, $AR_w = 7.3$, $\tau_w = 5$ m, $C_{L_{\alpha_{wf}}} = 0.07$/deg, $i_w = 2.0$, $C_{L_{\alpha=0}} = 0.26$. Estimate the horizontal tail area and tail incidence angle i_t, so that the complete airplane has the following pitching moment characteristics. $C_{m_{Cg_{wft}}} = 0.65 - 0.025\ \alpha$ where α is in degrees and wft is the wing fuselage tail contribution. Assume $\ell_t = 14.75$ m, $\eta = 1$, $AR_t = 4.85$, $C_{L_{\alpha_t}} = 0.073$/deg. **(12 Marks)**

   b. Explain longitudinal static stability and its criteria to achieve it. **(08 Marks)**

OR

2 a. Derive an expression for wing contribution for the longitudinal static stability of an airplane. **(10 Marks)**

   b. Derive the expression for elevator control power. **(10 Marks)**

Module-2

3 a. Derive the estimation of hinge moment parameters in stick free conditions. **(10 Marks)**

   b. Derive the expression for stick free neutral point. **(10 Marks)**

OR

4 a. Briefly explain about aerodynamic balancing in longitudinal stability. **(10 Marks)**

   b. Derive stick force gradients in an unaccelerated flight conditions. **(10 Marks)**

Module-3

5 a. Briefly explain the following terms with relevant sketches:
   (i)   Adverse yaw
   (ii) Cross wind landings
   (iii) Asymmetric power
   (iv) Spin recovery **(12 Marks)**

   b. Briefly explain about one engine inoperative condition. **(04 Marks)**

   c. Explain Rudder lock. **(04 Marks)**

OR

6 a. Write short notes on dihedral effect and aileron reversal. **(10 Marks)**

   b. Obtain the relation for lateral control power. **(10 Marks)**

Module-4

7 a. Derive rigid body equations of motion. **(12 Marks)**
   b. Obtain derivatives due to change in forward speed. **(08 Marks)**

OR

8 a. Obtain the derivatives due to the time rate of change of angle of attack of an airplane. **(10 Marks)**
   b. Obtain the derivative due to rolling rate. **(10 Marks)**

Module-5

9 a. Explain Dutch Roll and Spiral instability with relevant sketches. **(10 Marks)**
   b. Briefly explain about the Routh's criteria. **(10 Marks)**

OR

10 a. Explain briefly about the Cooper-Harper scale. **(10 Marks)**
   b. Write short notes on the following:
      (i)   Auto rotation
      (ii) Spin
      (iii) Wind shear **(10 Marks)**

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