



Seventh Semester B.E. Degree Examination, June/July 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 for the static longitudinal stability of an airplane. (08 Marks)
 b. 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.

$$S_w = 178m^2 ; \quad b_w = 35.9m ; \quad \tau_w = 5m ; \quad \chi_{cg/\bar{c}} = 0.1 ; \quad AR_w = 7.3 ;$$

$$C_{L_{\alpha_{wf}}} = 0.07 / \text{deg} ; \quad i_w = 2.0^\circ ; \quad C_{L_{\alpha=0}} = 0.26$$

Estimate the horizontal tail area and tail incidence angle, i_t , so that the complete airplane has the following pitching moment characteristics $C_{m_{cg_{wft}}} = 0.15 - 0.025\alpha$.

Where α is in degrees and wft is the wing-fuselage-horizontal tail contribution. Assume the following with regard to the horizontal tail;

$$l_t = 14.75m ; \quad \eta = 1 ; \quad AR_t = 4.85 ; \quad C_{L_{\alpha_t}} = 0.073 / \text{deg} . \quad (08 \text{ Marks})$$

OR

- 2 a. Write the expression for stick-fixed neutral point and discuss the CG range on the aircraft. (08 Marks)
 b. Derive the equation for elevator angle verses equilibrium lift co-efficient. (08 Marks)

Module-2

- 3 a. Explain hinge moment parameters. (08 Marks)
 b. Derive the equation for stick free Neutral points. (08 Marks)

OR

- 4 a. Briefly explain the requirements for directional control and obtain the expression for rudder control effectiveness, $C_{n_{\delta_r}}$. (10 Marks)
 b. What is meant by ‘Rudder lock’, ‘Dorsal fin’ and ‘Weather cocking effect’? (06 Marks)

Module-3

- 5 a. Explain Dihedral effect. (06 Marks)
 b. Explain the effect of wing sweep, flaps and power on Dihedral effect with neat diagram. (10 Marks)

OR

- 6 a. Obtain a relationship to rate of roll for a given stick force varies inversely with the density of the air and with the velocity, V and also inversely with the span to the fourth power. (08 Marks)
- b. Define longitudinal dynamic stability of airplane and plot the types of mode of motion and discuss about phugoid and short period motion. (08 Marks)

Module-4

- 7 a. Derive Rigid body equations of motion. (10 Marks)
- b. Briefly explain gravitational and thrust forces. (06 Marks)

OR

- 8 a. Derive the derivatives due to the pitching velocity. (08 Marks)
- b. Derive the derivatives due to the change in forward speed. (08 Marks)

Module-5

- 9 a. Explain Routh's criterion and determine whether the characteristic equations given below have stable or unstable roots :
 $\lambda^3 + 6\lambda^2 + 12\lambda + 8 = 0$
 $2\lambda^3 + 4\lambda^2 + 4\lambda + 12 = 0$. (08 Marks)
- b. Explain dutch roll and spiral instability with relevant sketches. (08 Marks)

OR

- 10 Write short notes on the following : (16 Marks)
- Flying qualities
 - Cooper – Harper scale
 - Wind shear
 - Auto-rotation and spin.

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