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Seventh Semester B.E. Degree Examination, June/July 2017

Aircraft Stability and Control

Time: 3 hrs.

Max. Marks:100

Note: Answer FIVE full questions, selecting at least TWO questions from each part.

PART – A

- 1 a. Explain longitudinal static stability. (06 Marks)
- b. Briefly explain Fuselage contribution to static stability using Multhopp's method. (10 Marks)
- c. For a given body combination, the aerodynamic centre lies 0.05 Chord ahead of C.G. The moment coefficient about the aerodynamic centre is -0.016. If the lift co-efficient is 0.45. calculate the moment coefficient about C.G. (04 Marks)

- 2 a. Derive an expression for elevator angle verses equilibrium lift coefficient. (10 Marks)
- b. Given the general aviation airplane with the following configuration details:
 $W = 2750 \text{ kg}$, $V = 176 \text{ m/s}$, $X_{cg} = 0.295 \bar{c}$, $S = 184 \text{ m}^2$, $b = 33.4 \text{ m}$,
 $l_t = 16 \text{ m}$, $\bar{c} = 5.7 \text{ m}$, $S_t = 43 \text{ m}^2$, $\eta = 1.0$, $C_{L_{\alpha_t}} = 3.91 \text{ rad}^{-1}$.

Assume that the pitching moment curve for the landing configuration for the forward most C.G. position is as follows: $C_{m_{cg}} = -0.20 - 0.035\alpha$ where α is in degrees. Estimate the flop effectiveness parameter and the size of the elevator to trim the airplane at the landing angle of attack of 10° , using Fig.Q2(b). Assume that the elevator angle is constrained to $+20^\circ$ and -25° .

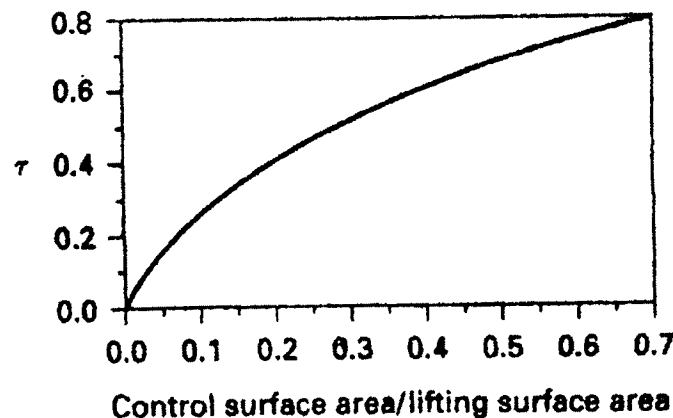


Fig.Q2(b)

- 3 a. Briefly explain Hinge moment parameters and trim tabs. (10 Marks)
- b. Derive an expression for stick-free neutral point with necessary graphs and compare it with stick-fixed neutral point. (10 Marks)

- 4 a. Define static direction stability of an airplane and the criteria with the relevant sketches and expressions. (06 Marks)
- b. Explain the following terms using direction control:
 - i) Adverse Yaw
 - ii) Cross-wind landings
 - iii) Asymmetric power
 - iv) Spin recovery
 (08 Marks)
- c. Explain what is meant by "Rudder lock" and the "Dorsal fin". (06 Marks)

PART – B

- 5 a. Explain the effect of Wing Sweep, flaps and power on dihedral effect. (08 Marks)
b. 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. (12 Marks)
- 6 a. Derive Rigid body equations of motion. (12 Marks)
b. Briefly explain gravitational and thrust forces. (08 Marks)
- 7 a. Explain aerodynamic force and moment representation. (10 Marks)
b. Derive the derivatives due to the time rate of change of the angle of attack. (10 Marks)
- 8 a. Briefly explain Dutch roll and spiral instability with relevant sketches. (10 Marks)
b. Briefly explain Routh's criterion and determine whether the characteristic equations given below have stable or unstable roots:
$$\lambda^3 + 6\lambda^2 + 12\lambda + 8 = 0$$
$$2\lambda^3 + 4\lambda^2 + 4\lambda + 12 = 0$$
 (10 Marks)

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