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10AE73

Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020
Aircraft Stability and Control

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting atleast TWO questions from each part.

PART - A

- 1 a. Explain the following terms with neat sketches : i) Equilibrium condition ii) Static stability and iii) Dynamic stability. (05 Marks)
- b. Derive expression for wing contribution $\left(\frac{dC_m}{dC_L}\right)_w$ for the longitudinal static stability of an airplane and discuss the significance of C.G. position with respect to the wing aerodynamic center. (10 Marks)
- c. For a given wing – body combination , the aerodynamic center lies 0.05 chord a head of the C.G. The moment co-efficient about the aerodynamic center is – 0.016. If the lift coefficient is 0.45, calculate the moment coefficient about C.G. (05 Marks)
- 2 a. Define Stick – fixed neutral point and derive an expression for it. (10 Marks)
- b. Define Elevator Control Power ($C_{m\delta_e}$) and derive an expression for it. How does elevator power affect the longitudinal stability? (07 Marks)
- c. Write a short – note on restriction on forward C.G. range. (03 Marks)
- 3 a. Write short notes on : i) Hinge moment parameters and ii) Control surface floating characteristics and aerodynamic balance. (10 Marks)
- b. Derive an expression for stick – force gradient (DFs/dv) in unaccelerated flight. Discuss how the stick force gradient affects the pilot opinion of an aircraft. (10 Marks)
- 4 a. Define Rudder control power $C_{n\delta_r}$ and derive an expression for it. (07 Marks)
- b. List the flight conditions that introduce yawing moments that must be overcome with the rudder control. (03 Marks)
- c. Write short notes on : i) Rudder lock and ii) Dorsal fin. (10 Marks)

PART - B

- 5 a. Define 'Dihedral Angle' and 'Dihedral Effect' and discuss their effect on the roll stability of aircraft. (05 Marks)
- b. Explain the various methods of Aileron balancing. (05 Marks)
- c. Explain aileron control forces during maneuvers and derive the expression for stick force requirement in the form

$$F_a = -q S_a C_a G C_{h\delta} \delta_a \left[1 - 2n \frac{C_{h\alpha}}{C_{h\delta}} \right]. \quad (10 \text{ Marks})$$

- 6 a. Define Dynamic longitudinal stability and briefly explain the following with relevant sketch i) Phugoid mode and ii) Short – period mode. (05 Marks)
- b. Derive rigid body equation of motion of an aircraft. (15 Marks)

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- 7 a. Obtain the stability derivatives due to change in pitching velocity (q). (10 Marks)
b. Write short notes on :
i) Aerodynamic force and moment representation. (10 Marks)
ii) Small disturbance theory.
- 8 Write short notes on :
a. Routh's stability criteria.
b. Flying qualities in pitch.
c. Auto – rotation and spin.
d. Cooper – Harper Rating scale. (20 Marks)
