

CBCS SCHEME

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21AE/AS54

Fifth Semester B.E. Degree Examination, June/July 2024 Aircraft Performance and Stability

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. With neat diagram, derive the expression for power required and condition for minimum power required. (10 Marks)
- b. Plot the thrust required curve and prove graphical approach is equal to analytical approach with the following data:
Flying altitude : 10 km
Maximum Take-off weight : 3,00,000 N
Wing plan form area = 90 m²
Aspect ratio = 6.9
Parasite drag coefficient, $C_{D_0} = 0.015$, $K = 0.08$
Atmospheric density at 10 km = 0.5 kg/m³ (10 Marks)

OR

- 2 a. With graphical approach, explain:
(i) Power available and power required
(ii) Thrust available and thrust required (10 Marks)
- b. Discuss with graphs the equation for sink rate and time to glide. (10 Marks)

Module-2

- 3 a. Derive the condition and the velocity associated with $\left(\frac{C_L^{1/2}}{C_D}\right)_{\max}$. (10 Marks)
- b. Derive Breguet Range and Endurance equation for propeller engine aircraft. (10 Marks)

OR

- 4 a. Consider Gulfstream IV aircraft flying at 8 km altitude. Estimate the maximum range and endurance at this altitude. Consider the following conditions:
Maximum usable fuel weight = 1,30,000 N
Thrust specific fuel consumption = 3.05 N/hr-N
Weight of the aircraft = 3,25,000 N
Wing plan form area = 88 m²
Aspect ratio = 5.92
Air density = 0.65 kg/m³
Drag polar, $C_D = 0.014 + 0.07 C_k^2$ (10 Marks)
- b. Derive Breguet range and endurance equation for jet engine powered aircraft. (10 Marks)

Module-3

- 5 a. With neat diagram explain ground effects on a typical passage aircraft. (10 Marks)
- b. Explain level turn in a steady flight and with neat diagram, derive an equation for turn radius. (10 Marks)

OR

- 6 a. With neat diagram, explain V-n diagram for a passenger aircraft. (10 Marks)
 b. Explain in detail the pull-up and pull-down maneuvers of steady aircraft with appropriate equations. (10 Marks)

Module-4

- 7 a. With neat diagram, bring out the differences between absolute angle of attack and geometric angle of attack. (06 Marks)
 b. Derive the necessary and sufficient condition for longitudinal static stability. (08 Marks)
 c. Discuss the salient features of Wright flyer 1. (06 Marks)

OR

- 8 a. Prove that static margin is the direct measure of static longitudinal stability of the airplane. (10 Marks)
 b. A wing body model is tested in a subsonic wind tunnel. The lift is found to be zero at geometric angle of attack -1.5° . At 5° geometric angle of attack, the lift coefficient is measured as 0.52. Also at $\alpha = 1^\circ$ and 7.88° , the moment coefficient is measured as -0.01 and 0.05 respectively. The CG is located at $0.35C$. Calculate the location of aerodynamic centre and the value of $C_{M,ac_{wb}}$. (10 Marks)

Module-5

- 9 a. Derive equations for stick-free neutral point. (08 Marks)
 b. Explain any three methods of aerodynamic balancing. (06 Marks)
 c. Explain the effect of wing dihedral to the lateral stability of the aircraft. (06 Marks)

OR

- 10 a. Explain the contribution of wing position and vertical stabilizer on the lateral stability of the aircraft. (10 Marks)
 b. With neat diagram, explain Rudder lock and also discuss a method to overcome rudder lock. (10 Marks)
