

CBCS SCHEME

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18AE61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023 Aircraft Performance

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Derive the equations of motion for an leveled and unaccelerated flight and hence prove the condition for minimum thrust required. (10 Marks)
- b. Consider a twin turbofan executive aircraft flying at 9km altitude with following data :
Gross weight = 30000kg, surface area = 90m², K = 0.09, C_{D0} = 0.03, m = 0.6 and max thrust of each engine at sea level 60,000N. Take density at 9km altitude as 0.467kg/m³ and at sea level 1.225kg/m³. Calculate min thrust required, velocity at min thrust and maximum velocity. (10 Marks)

OR

- 2 For the airplane data given in Q1(b), graphically determine the value of,
- Minimum thrust required
 - Velocity at min thrust
 - Maximum velocity
 - Min power required
 - Velocity at min power
- Plot the graph of T_R vs V_∞ and P_R vs V_∞. (20 Marks)

Module-2

- 3 a. Derive the equations of motion for climb performance and show that, rate of climb is directly proportional to the excess power. Draw relevant plots. (10 Marks)
- b. Derive the equations of motion for unpowered flight. (05 Marks)
- c. Consider an aircraft flying at 10km altitude. Assume a total loss of engine thrust. Calculate :
i) Min glide path angle
ii) Max range covered over ground
iii) Corresponding equilibrium glide velocity at 10km altitude. Given K = 0.08, C_{D0} = 0.015, L/D_{max} = 15, W/S = 80 and density at 10km altitude is 0.4135 kg/m³. (05 Marks)

OR

- 4 a. Derive an analytical equation for velocity at maximum rate of climb. (10 Marks)
- b. Explain hodograph with neat sketch. (05 Marks)
- c. Define the terms absolute ceiling and service ceiling. (05 Marks)

Module-3

- 5 a. What is Drag polar? Derive an equation for drag polar. (08 Marks)
- b. Derive the aerodynamic relations related to lift to drag ratio. (08 Marks)
- c. An aircraft has wing loading of 2400N/m² and C_{Lmax} = 1.4. Find the airspeed at which stall occurs at,
i) sea level, where ρ = 1.225 kg/m³
ii) 5km, where ρ = 0.737 kg/m³. (04 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg. 42+8 = 50, will be treated as malpractice.

OR

- 6 a. Derive the Breguet's formula for range and endurance for propeller engine aircraft. Also explain the factors influencing range and endurance. (10 Marks)
- b. Calculate range of jet airplane having following characteristics. Gross weight = 9000kg, fuel weight = 3388 kg, wing area = 29.5m², SFC = 0.8×10^{-6} kg/kg sec, C_L and C_D at an altitude of 6800m is 1.856 and 0.0582 respectively free stream density at the altitude is 0.6035 kg/m³. (10 Marks)

Module-4

- 7 a. Define the terms : critical engine failure speed, minimum unstick speed take off rotational speed total take off distance and balance field length. (10 Marks)
- b. Derive an equation for ground roll distance during takeoff, starting with Newton's second law of motion. (10 Marks)

OR

- 8 a. Derive an equation for approach distance during landing. (08 Marks)
- b. Derive an equation for airborne distance covered to clear an obstacle during takeoff. (07 Marks)
- c. Explain the forces acting on aircraft at takeoff and landing with the help of force diagram. (05 Marks)

Module-5

- 9 a. Explain level turn in a steady flight and derive the equations for turn radius and turn rate. (10 Marks)
- b. Derive an equation for maximum load factor during sustained level turn. (10 Marks)

OR

- 10 a. Derive the equations for minimum turn radius for a steady level flight. (08 Marks)
- b. Explain Vn diagram with a neat sketch. (08 Marks)
- c. An aircraft is performs pullup and pulldown maneuver at a true speed of 200m/s at a load factor of 6. Calculate turn radius and turn rate in both maneuvers. (04 Marks)
