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 = $90m^2$, 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 $0.467kg/m^3$ and at sea level $1.225kg/m^3$. 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,

a. Minimum thrust required
b. Velocity at min thrust
c. Maximum velocity
d. Min power required
e. 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 $0.4135\ kg/m^3$. **(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 $2400N/m^2$ and C_{Lmax} = 1.4. Find the airspeed at which stall occurs at,

i) sea level, where $\rho = 1.225\ kg/m^3$
ii) 5km, where $\rho = 0.737\ kg/m^3$. **(04 Marks)**

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 = 29.5m^2, 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/m^3. **(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' 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)**

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